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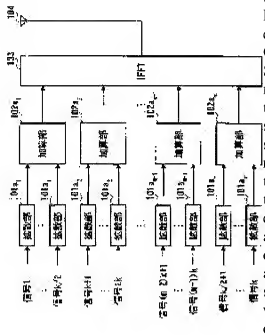
(54) OFDM-DS-CDMA COMMUNICATION SYSTEM



(57)Abstract:
PROBLEM TO BE SOLVED: To reduce deterioration in an error rate characteristics of an OFDM- DS-CDMA communication system.
SOLUTION: Adder sections 102a1, 102am multiplex k/2-sets of spread information signals to generate a multiplexed signal. The adder sections 102a1-102am-1 multiplex k-sets of spread information signals to generate a multiplexed signal. An IFFT section 103 assigns the multiplex signal from the adder section 102a1 to a subcarrier 1 whose characteristics is deteriorated and the multiplex signal from the adder section 102am to a subcarrier m whose characteristics is deteriorated respectively and assigns the multiplex signal from the adder sections 102a1-102am-1 to subcarriers 2-m-1 with excellent characteristics respectively to conduct frequency division multiplexing.

CLAIMS

[Claim(s)]
[Claim 1]A multiplex means to generate a multiple signal by diffusing and carrying out multiplex [of the information signal], Provide a Frequency-Division-Multiplexing means to perform Frequency-Division-Multiplexing processing by assigning said each multiple signal to a subcarrier peculiar to a multiple signal, and said multiplex means, An OFDM-DS-CDMA communication device setting up the number of information signals which carry out multiplex according to the characteristic of a subcarrier that a generated multiple signal is assigned.
[Claim 2]The OFDM-DS-CDMA communication device according to claim 1, wherein a size of influence by an adjacent-channel-interference wave in this subcarrier or a size of influence by an analog filter is used for said multiplex means as the characteristic of said subcarrier.
[Claim 3]The OFDM-DS-CDMA communication device according to claim 1 or 2 when said multiplex means has deteriorated [the characteristic of said subcarrier], wherein it sets up small the number of said information signals which carry out multiplex compared with other multiplex means.
[Claim 4]When a multiplex means by which the characteristic of said subcarrier has deteriorated diffuses and carries out multiplex [of the information signal of a predetermined number] among information signals which carry out multiplex, Provide a 2nd multiplex means to generate a multiple signal instead of a multiplex means by which the characteristic of said subcarrier has deteriorated, and said Frequency-Division-Multiplexing means, The OFDM-DS-CDMA communication device according to any one of claims 1 to 3 assigning a multiple signal generated by said 2nd multiplex means to DC subcarrier.
[Claim 5]A communication terminal device provided with the OFDM-DS-CDMA communication device according to any one of claims 1 to 4.
[Claim 6]A base station device provided with the OFDM-DS-CDMA communication device according to any one of claims 1 to 4.
[Claim 7]A multiplex process of generating a multiple signal by diffusing and carrying out multiplex [of the information signal], Provide a Frequency-Division-Multiplexing process of performing Frequency-Division-Multiplexing processing by assigning said each multiple signal to a subcarrier peculiar to a multiple signal, and said multiplex process, An OFDM-DS-CDMA correspondence procedure setting up the number of information signals which carry out multiplex according to the characteristic of a subcarrier that a generated multiple signal is assigned.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention about the communication apparatus used for a digital mobile communications system, Especially, It is related with the communication

apparatus which performs radio of the OFDM-CDMA system which combined the CDMA (Code Division Multiple Access) method and the OFDM (Orthogonal Frequency Division Multiplexing) method.

[0002]

[Description of the Prior Art]These days, communication of the OFDM-CDMA system which combined the CDMA system and the OFDM system attracts attention, and is considered briskly. This OFDM-CDMA system is mainly classified into the method (generally called the "OFDM-CDMA" method.) which arranges the signal after diffusion to a frequency direction, and the method (generally called the "OFDM-DS-CDMA" method.) which arranges the signal after diffusion to a time base direction. Hereafter, the communication apparatus (henceforth "an OFDM-DS-CDMA communication device") using an OFDM-DS-CDMA system is explained.

[0003]Drawing 6 is a block diagram showing the composition of the transmission system in the conventional OFDM-DS-CDMA communication device. Here, the total of the subcarrier (subcarrier) to be used is set to m as an example.

[0004]With reference to drawing 6, it receives for every subcarrier used as an assignment place, and k diffused parts and one adder unit are provided. Namely, to the subcarrier 1, k diffused part $601a_1$ and adder unit $602a_1$ are provided, and the subcarrier 2 is received, k diffused part $601a_2$ and adder unit $602a_2$ are provided, and k diffused part $601a_m$ and adder unit $602a_m$ are similarly provided to the subcarrier m.

[0005]k signals which consist of the signals 1 - the signals k among mk piece signals (information signal), It is considered as the signal assigned to the subcarrier 1, k signals which consist of the signals k+1 - the signals 2k are made into the signal assigned to the subcarrier 2, and k signals of the signal (m-1) k+1 - the signal mk are similarly made into the signal assigned to the subcarrier m.

[0006]k signals assigned to the subcarrier n (n=1-m) are diffused by the diffused part provided to this subcarrier, respectively. That is, the signal 1 - the signal k which are assigned to the subcarrier 1 are diffused by diffused part $601a_1$ provided to the subcarrier 1. Similarly, the signal (m-1) k+1 - the signal mk which are assigned to the subcarrier m are diffused by diffused part $601a_m$ provided to the subcarrier m. Mutually different spread code series are used in k diffused part $601a_n$ provided to the subcarrier n.

[0007]Multiplex [of the k signals diffused by diffused part $601a_n$] is carried out by adder unit $602a_n$. The total (henceforth "a signal multiplexed number") of the signal in which multiplex is carried out by adder unit $602a_n$ is set to k. The signal (henceforth a "multiple signal"), as for, multiplex was carried out by adder unit $602a_n$ is sent to the IFFT (Inverse Fast Fourier Transform) section 603.

[0008]In IFFT part 603, the IFFT (inverse Fourier transform) processing to the multiple signal from adder unit $602a_n$, i.e., Frequency-Division-Multiplexing processing, is made. The subcarrier n is assigned to the multiple signal from adder unit $602a_n$, and, specifically, Frequency-Division-Multiplexing processing is made.

[0009]How to assign a subcarrier is as being shown in drawing 8. That is, the subcarrier 1 is assigned to the multiple signal from adder unit $602a_1$, the subcarrier 2 is assigned to the multiple signal from adder unit $602a_2$, and the subcarrier m is similarly assigned to the multiple signal from adder unit $602a_m$.

[0010]By the Frequency-Division-Multiplexing processing in above IFFT parts 603, the signal with which the subcarrier was overlapped on the multiple signal from adder unit

$602a_n$ is acquired.
[0011]As for the signal acquired by Frequency-Division-Multiplexing processing, a sending signal is generated by making predetermined transmitting processing. The format of a sending signal is as being shown in drawing 9. Here, T is an OFDM symbol cycle. The situation of three OFDM symbols is shown in drawing 9. Parallel-serial-conversion processing, D/A conversion processing, frequency conversion processing, a band limiting process, etc. are included in the above-mentioned predetermined transmitting processing. This sending signal is transmitted to a communications partner via the antenna 604.
[0012]Drawing 7 is a block diagram showing the composition of the receiving system in the conventional OFDM-DS-CDMA communication device. With reference to drawing 7, k back-diffusion-of-gas parts are provided for every subcarrier. That is, k back-diffusion-of-gas part $703a_n$ is provided to the subcarrier n (n=1-m).
[0013]The signal transmitted by the communications partner is received by this communication apparatus via the antenna 701. The above-mentioned communications partner is provided with the communication apparatus shown in drawing 6.
The sending signal acquired by performing processing mentioned above is transmitted.

[0014]As for the input signal from the antenna 701, predetermined reception is made. A band limiting process, frequency conversion processing, amplification processing, A/D conversion processing, in-series parallel-conversion processing, etc. are included in the above-mentioned predetermined reception. The input signal with which the above-mentioned predetermined reception was made is sent to the FFT (Fast Fourier Transform) section 702.
[0015]In FFT section 702, the signal transmitted by each subcarrier of the subcarrier 1 - the subcarrier m is taken out by performing FFT (Fourier transform) processing to the input signal with which the above-mentioned predetermined reception was made.
[0016]Back-diffusion of gas of the signal transmitted by the subcarrier n is carried out by back-diffusion-of-gas part $703a_n$. That is, back-diffusion of gas of the signal transmitted by the subcarrier 1 is carried out by back-diffusion-of-gas part $703a_1$, and back-diffusion of gas of the signal transmitted by the subcarrier m is similarly carried out by back-diffusion-of-gas part $703a_m$. As a result, k signals which consist of the signals 1 - the signals k by back-diffusion-of-gas part $703a_1$ are extracted, and k signals which consist of the signals (m-1) k+1 - the signals mk by back-diffusion-of-gas part $703a_m$ are extracted similarly.
[0017]
[Problem(s) to be Solved by the Invention]However, in the above-mentioned conventional OFDM-DS-CDMA communication device, there is a problem that degradation of error rate characteristics becomes large as the signal transmitted for referring to drawing 8 by the subcarrier which is separated from center frequency on a center frequency axis. The cause that the error rate characteristics of the signal hereafter transmitted by the subcarrier which is separated from center frequency fall is explained.
[0018]The influence by the interference wave (henceforth "an adjacent-channel-interference wave") of an adjacent channel is mentioned [1st] first. In drawing 10, the subcarrier group 1001 shows the example of arrangement of the subcarrier used for a desired signal (desired channel). The channel which adjoins this desired channel on a frequency axis here may exist. In this case, as shown in drawing 10, the interference

wave 1002, i.e., the 1st adjacent-channel-interference wave, and the 2nd adjacent-channel-interference wave 1003 of an adjoining channel may give interference to a desired channel.
[0019]In such a case, in a receiving system, the analog amplifier used at the time of amplification processing generates an unnecessary-frequencies ingredient under the influence of each above-mentioned adjacent-channel-interference wave. By this, a desired signal will be overlapped on the above-mentioned unnecessary-frequencies ingredient.
[0020]Here, the ingredient of an adjacent-channel-interference wave becomes so small that it separates from the center frequency of this adjacent channel on a frequency axis so that clearly from drawing 10. If it puts in another way, in a desired channel, the subcarrier in which the influence of an adjacent-channel-interference wave separated from the center frequency of this desired channel will become large. Therefore, in a desired signal, since the subcarrier which is more nearly separated from the center frequency of a desired channel is easy to be superimposed on an unnecessary-frequencies ingredient, the characteristic will deteriorate. As a result, in the signal transmitted by the subcarrier which is separated from center frequency on a center frequency axis, degradation of error rate characteristics becomes large.
[0021]The influence of the analog filter used [2nd] in a transmission system is mentioned. Usually, in a transmission system, in order to remove the unnecessary-frequencies ingredient of the sending signal changed into the analog signal from the digital signal, it lets this sending signal pass to an analog filter.
[0022]In drawing 11, the above-mentioned analog filter has a filter damping property which has a filter phase characteristic which is expressed by the characteristic curve 1102 to the subcarrier group 801, and is expressed by the characteristic curve 1103.
[0023]When a sending signal passes the analog filter which has the above characteristics, since the subcarrier near the cutoff frequency of a filter, i.e., the subcarrier which is separated from center frequency, is influenced by electric power attenuation, phase rotation, etc., the characteristic deteriorates. For this reason, in the signal transmitted by the subcarrier which is separated from center frequency, in a receiving system, degradation of error rate characteristics becomes large.
[0024]As mentioned above, in the conventional OFDM-DS-CDMA communication device, the error rate characteristics of the signal transmitted by the subcarrier which is separated from the center frequency of a desired signal with the characteristic of an adjacent-channel-interference wave and an analog filter deteriorate.
[0025]This invention is made in view of this point, and is a thing.
The purpose is to provide the OFDM-DS-CDMA communication device which reduces degradation of **.

[0026]
[Means for Solving the Problem]An OFDM-DS-CDMA communication device of this invention, A multiplex means to generate a multiple signal by diffusing and carrying out multiplex [of the information signal], By assigning said each multiple signal to a subcarrier peculiar to a multiple signal, a Frequency-Division-Multiplexing means to perform Frequency-Division-Multiplexing processing is provided, and said multiplex means sets up the number of information signals which carry out multiplex according to

the characteristic of a subcarrier that a generated multiple signal is assigned.
[0027]According to this invention, degradation of the error rate characteristics of a signal transmitted by the above-mentioned subcarrier can be suppressed by setting up a signal multiplexed number of a signal assigned to each subcarrier according to the characteristic of each subcarrier.
[0028]As for said multiplex means, a size of influence by an adjacent-channel-interference wave in this subcarrier or a size of influence by an analog filter is used for an OFDM-DS-CDMA communication device of this invention as the characteristic of said subcarrier.
[0029]According to this invention, according to a size of influence by an adjacent-channel-interference wave in each subcarrier, and a size of influence by the analog filter characteristic, corresponding to the characteristic of each subcarrier, By setting up a signal multiplexed number of a signal assigned to each subcarrier, degradation of the error rate characteristics of a signal transmitted by the above-mentioned subcarrier can be suppressed.
[0030]As for an OFDM-DS-CDMA communication device of this invention, said multiplex means sets up small the number of said information signals which carry out multiplex compared with other multiplex means, when the characteristic of said subcarrier has deteriorated.
[0031]According to this invention, when the characteristic of a subcarrier used as an assignment place of a generated multiple signal has deteriorated, degradation of the error rate characteristics of a signal transmitted by this subcarrier can be suppressed by making small a signal multiplexed number of a signal assigned to this subcarrier compared with other subcarriers.
[0032]An OFDM-DS-CDMA communication device of this invention, When a multiplex means by which the characteristic of said subcarrier has deteriorated diffuses and carries out multiplex [of the information signal of a predetermined number] among information signals which carry out multiplex, Providing a 2nd multiplex means to generate a multiple signal instead of a multiplex means by which the characteristic of said subcarrier has deteriorated, said Frequency-Division-Multiplexing means assigns a multiple signal generated by said 2nd multiplex means to DC subcarrier.
[0033]When an information signal of a part which decreased a signal multiplexed number and was decreased about a signal assigned to a subcarrier in which the characteristic has deteriorated assigns a signal by which multiplex was carried out to DC subcarrier according to this invention, Degradation of the error rate characteristics of a signal transmitted by each subcarrier can be suppressed preventing decline in transmission efficiency.
[0034]A communication terminal device of this invention was provided with an OFDM-DS-CDMA communication device of one of the above.
[0035]According to this invention, a communication terminal device which performs good communication can be provided by having an OFDM-DS-CDMA communication device which reduces degradation of error rate characteristics.
[0036]A base station device of this invention was provided with an OFDM-DS-CDMA communication device of one of the above.
[0037]According to this invention, a base station device which performs good communication can be provided by having an OFDM-DS-CDMA communication device

which reduces degradation of error rate characteristics.
[0038]An OFDM-DS-CDMA correspondence procedure of this invention, A multiplex process of generating a multiple signal by diffusing and carrying out multiplex [of the information signal], By assigning said each multiple signal to a subcarrier peculiar to a multiple signal, a Frequency-Division-Multiplexing process of performing Frequency-Division-Multiplexing processing is provided, and said multiplex process sets up the number of information signals which carry out multiplex according to the characteristic of a subcarrier that a generated multiple signal is assigned.
[0039]According to this invention, degradation of the error rate characteristics of a signal transmitted by the above-mentioned subcarrier can be suppressed according to this invention by setting up a signal multiplexed number of a signal assigned to each subcarrier according to the characteristic of each subcarrier.
[0040]
[Embodiment of the Invention]The main point of this invention is having set up the signal multiplexed number of the signal assigned to each subcarrier according to the characteristic of a subcarrier (subcarrier).
[0041]Hereafter, an embodiment of the invention is described in detail with reference to drawings.
[0042](Embodiment 1) Drawing 1 is a block diagram showing the composition of the transmission system of the OFDM-DS-CDMA communication device concerning the embodiment of the invention 1. Drawing 2 is a block diagram showing the composition of the receiving system of the OFDM-DS-CDMA communication device concerning the embodiment of the invention 1. They shall be the subcarrier 1 - the subcarrier m about the subcarrier (subcarrier) which the OFDM-DS-CDMA communication device concerning this embodiment uses as an example here.
[0043]In the OFDM-DS-CDMA communication device concerning this embodiment, the center frequency of an adjacent-channel-interference wave may be known [and / the characteristic of the analog filter to be used]. Specifically, for example this adjacent-channel-interference wave, Interference which exceeds a predetermined threshold to the subcarrier 1 and the subcarrier m which were most separated from center frequency on the frequency axis is given (if it says conversely). The characteristic of the subcarrier 1 and a subcarrier, Assume that it has deteriorated under the influence of an adjacent-channel-interference wave, and the above-mentioned analog filter, It shall have influence of electric power attenuation, phase rotation, etc. which exceed a predetermined threshold to the subcarry 1 and the subcarrier m (if it says conversely, the characteristic of the subcarrier 1 and the subcarrier m will be ******ed under the influence of an analog filter).
[0044]First, the transmission system of the OFDM-DS-CDMA communication device concerning this embodiment is explained with reference to drawing 1. With reference to drawing 1, it receives for every (except for the subcarrier 1 and the subcarrier m) subcarrier used as an assignment place, and k diffused parts and one adder unit are provided. However, to the subcarrier 1 and the subcarrier m used as an assignment place, k/2 diffused parts and one adder unit are provided.
[0045]That is, to the subcarrier 2, k diffused part $101a_2$ and one adder unit $102a_2$ are provided, and k diffused part $101a_{m-1}$ and one adder unit $102a_{m-1}$ are similarly provided to the subcarrier m-1. To the subcarrier 1, k/2 diffused part $101a_1$ and one adder unit $102a_1$

are provided, and k/2 diffused part $101a_m$ and one adder unit $102a_m$ are similarly provided to the subcarrier m.

[0046]k/2 which consist of signal k/[the signal 1 -] 2 among all the signals (all the information signals) signals are made into the signal assigned to the subcarrier 1, and k/2 which consist of signal k/2+1 - the signal k signals are made into the signal assigned to the subcarrier m. k signals which consist of the signals k+1 - the signals 2k among all the signals (all the information signals) are made into the signal assigned to the subcarrier 2, and k signals of the signal (m-2) k+1 - the signal (m-1) k are similarly made into the signal assigned to the subcarrier m-1.

[0047]k/2 assigned to the subcarrier j (j= 1, m) signals are diffused by the diffused part provided to this subcarrier, respectively. That is, signal k / [the signal 1 -] 2 assigned to the subcarrier 1 are diffused by diffused part $101a_1$ provided to the subcarrier 1. Similarly, signal k/2+1 assigned to the subcarrier m - the signal k are diffused by diffused part $101a_m$ provided to the subcarrier m. In k/2 provided to the subcarrier j diffused part $101a_j$, a spread code series which is mutually different is used.

[0048]k signals assigned to the subcarrier n (n= 2 to m-1) are diffused by the diffused part provided to this subcarrier, respectively. That is, the signal k+1 - the signal 2k which are assigned to the subcarrier 2 are diffused by diffused part $101a_2$ provided to the subcarrier 2. Similarly, the signal (m-2) k+1 - the signal (m-1) k which are assigned to the subcarrier m-1 are diffused by diffused part $101a_{m-1}$ provided to the subcarrier m-1. Mutually different spread code series are used in k diffused part $101a_n$ provided to the subcarrier m.

[0049]In the diffused part provided corresponding to each subcarrier, the spread code series assigned to each diffused part is a basis of the conditions of differing in other diffused parts and mutual, and how to assign the spread code series over a diffused part can be determined as follows. Namely, a common spread code series may be assigned to the diffused part provided corresponding to each subcarrier in all the subcarriers, and a peculiar spread code series may be assigned for every diffused part provided corresponding to each subcarrier. In the diffused part provided corresponding to each subcarrier, it is also possible to assign a common spread code series to the diffused part corresponding to a specific subcarrier.

[0050]Multiplex [of the k/2 diffused by diffused part $101a_j$ signals] is carried out by adder unit $102a_j$, and multiplex [of the k signals diffused by diffused part $101a_n$] is carried out by adder unit $602a_n$. The signal multiplexed number in adder unit $102a_j$ will be k/2, and the signal multiplexed number in adder unit $102a_n$ is set to k. Namely, the interference by the adjacent-channel-interference wave which exceeds a predetermined threshold, Or a signal multiplexed number is set to k/2 [smaller than the signal multiplexed number k of other subcarriers] about the subcarrier (the subcarrier 1 and the subcarrier m) influenced by electric power attenuation, phase rotation, etc. which exceed a predetermined threshold.

[0051]The multiple signal from adder unit $102a_j$ and adder unit $102a_n$ is sent to IFFT part 103. In IFFT part 103, the IFFT (inverse Fourier transform) processing to the multiple signal from adder unit $102a_j$ and adder unit $102a_n$, i.e., Frequency-Division-Multiplexing processing, is made. The subcarrier 1 - the subcarrier m are assigned to the multiple signal from adder unit $102a_j$ and adder unit $102a_n$, and, specifically, Frequency-Division-Multiplexing processing is made.

[0052]How to assign a subcarrier is as being shown in drawing 8. That is, the subcarrier 1 is assigned to the multiple signal from adder unit $102a_1$, the subcarrier 2 is assigned to the multiple signal from adder unit $602a_2$, and the subcarrier m is similarly assigned to the multiple signal from adder unit $602a_m$.
[0053]By the Frequency-Division-Multiplexing processing in above IFFT parts 103, the signal with which the subcarrier was overlapped on the multiple signal from adder unit $102a_j$ and adder unit $102a_n$ is acquired.
[0054]As for the signal acquired by Frequency-Division-Multiplexing processing, a sending signal is generated by making predetermined transmitting processing. The format of a sending signal is as being shown in drawing 3. Here, T is an OFDM symbol cycle. The situation of three OFDM symbols is shown in drawing 3. Parallel-serial-conversion processing, D/A conversion processing, frequency conversion processing, a band limiting process, etc. are included in the above-mentioned predetermined transmitting processing. This sending signal is transmitted to a communications partner via the antenna 104.
[0055]Next, the receiving system of the OFDM-DS-CDMA communication device concerning this embodiment is explained with reference to drawing 2. With reference to drawing 2, k/2 piece or k back-diffusion-of-gas parts are provided for every subcarrier. That is, k/2 back-diffusion-of-gas part $203a_j$ is provided to the subcarrier j (j= 1, m), and k back-diffusion-of-gas part a_n is provided to the subcarrier n (n= 2 to m-1).
[0056]The signal transmitted by the communications partner is received by this communication apparatus via the antenna 201. The above-mentioned communications partner is provided with the communication apparatus shown in drawing 1, and transmits the sending signal acquired by performing processing mentioned above.
[0057]As for the input signal from the antenna 201, predetermined reception is made. A band limiting process, frequency conversion processing, amplification processing, A/D conversion processing, in-series parallel-conversion processing, etc. are included in the above-mentioned predetermined reception. The input signal with which the above-mentioned predetermined reception was made is sent to FFT section 202.
[0058]In FFT section 202, the signal transmitted by each subcarrier of the subcarrier 1 - the subcarrier m is taken out by performing FFT (Fourier transform) processing to the input signal with which the above-mentioned predetermined reception was made.
[0059]Back-diffusion of gas of the signal transmitted by the subcarrier j is carried out by back-diffusion-of-gas part $203a_j$, and back-diffusion of gas of the signal transmitted by the subcarrier n is carried out by back-diffusion-of-gas part $203a_n$. As a result, k/2 which consist of signal k/k/2 signal and 2+1 - the signal k which consist of signal k/[the signal 1 -] 2, respectively by back-diffusion-of-gas part $203a_1$ and back-diffusion-of-gas part $203a_m$ signals are extracted. k signals which consist of the signals k+1 - the signals 2k by back-diffusion-of-gas part $203a_2$ are extracted, and k signals which consist of the signals (m-2) k+1 - the signals (m-1) k by back-diffusion-of-gas part $203a_{m-1}$ are extracted similarly.
[0060]The subcarrier in which interference by an adjacent-channel-interference wave exceeds a predetermined threshold so that clearly from the above explanation, And the influence of electric power attenuation, phase rotation, etc. by an analog filter makes small the signal multiplexed number of the signal assigned to this subcarrier about the subcarrier (namely, subcarrier generally separated from the center frequency of the desired signal on the frequency axis) which exceeds a predetermined threshold. For

example, as a signal multiplexed number of the signal assigned to the subcarrier 1 and the subcarrier m, it replaces with the signal multiplexed number k of the signal assigned to other subcarriers, and k/2 is used.

[0061]Generally, in an OFDM-DS-CDMA system, degradation of the error rate characteristics in a receiving system can be suppressed by making a signal multiplexed number small. Therefore, the demodulation signal acquired by the back-diffusion-of-gas processing to the signal transmitted by the subcarrier 1 and the subcarrier m turns into a signal with good error rate characteristics.

[0062]Here, although the transmission efficiency of these subcarriers falls by having made small the signal multiplexed number of the signal assigned to the subcarrier 1 and the subcarrier m, when there are many total subcarriers, the decline in overall transmission efficiency will become [few]. For example, when the total number of subcarriers is set to 32 and the signal multiplexed number of the signal assigned to two subcarriers most separated from center frequency on the frequency axis is set to one half, it is only that the whole transmission efficiency falls about 3%.

[0063]Although the case where the center frequency of an adjacent-channel-interference wave was known was explained so far, This invention can be applied also when a signal level, a phase, etc. of the case where the center frequency and the signal level of an adjacent-channel-interference wave are not known, and an adjacent-channel-interference wave change with phasing etc. In this case, the influence of adjacent-channel-interference wave interference etc. should just make small the signal multiplexed number of the signal which detects the subcarrier which exceeds a predetermined threshold and assigns it to the detected subcarrier among all the subcarriers.

[0064]Thus, the subcarrier which is easy to be influenced by adjacent-channel-interference wave interference and the analog filter characteristic among all the subcarriers according to this embodiment (especially) Degradation of the error rate characteristics of the signal transmitted by the above-mentioned subcarrier can be suppressed by making smaller than the signal multiplexed number of the signal assigned to other subcarriers the signal multiplexed number of the signal assigned to the subcarrier which is separated from the center frequency of a desired signal. According to the characteristic of each subcarrier, i.e., the size of the influence by an adjacent-channel-interference wave [in / for example, / each subcarrier] and the size of the influence by the analog filter characteristic, if it puts in another way, By setting up the number of multiple signals of the signal assigned to each subcarrier, degradation of the error rate characteristics of the signal transmitted by the above-mentioned subcarrier can be suppressed.

[0065]Although the case where the signal multiplexed number of the signal assigned to the subcarrier which is easy to receive the influence of an adjacent-channel-interference wave and the influence of the analog filter characteristic in this embodiment was set to one half of the signal multiplexed numbers of the signal assigned to other subcarriers was explained, This invention is not limited to this but can be applied also to the case where a signal multiplexed number is set up, for every above-mentioned subcarrier according to an adjacent-channel-interference wave, the size of the influence of an analog filter, etc. Thereby, when the influence of adjacent-channel-interference wave interference and the analog filter characteristic is different for every subcarrier, degradation of error rate characteristics can be suppressed.

[0066]In this embodiment, the still more nearly following effects are acquired by making small the signal multiplexed number of the signal assigned to the subcarrier separated from center frequency on the frequency axis. That is, in an OFDM system, an OFDM-CDMA system, and an OFDM-DS-CDMA system, an unnecessary-frequencies ingredient occurs by the side lobe component of each subcarrier in a certain desired signal. The unnecessary-frequencies ingredient by the side lobe component of the subcarrier which is separated from center frequency among the unnecessary-frequencies ingredients by each of these subcarriers is based on this desired signal, and also it turns into an interferent component to a channel.

[0067]Here, in this embodiment, the signal level of the subcarrier which made the signal multiplexed number small can be made small. That is, the signal level of the subcarrier which is separated from center frequency can be made small. Thereby, this desired signal can also reduce interference given to other channels.

[0068](Embodiment 2) By this embodiment, in Embodiment 1, when there are few total subcarriers, the case where it is made not to reduce transmission efficiency is explained.

[0069]In Embodiment 1 mentioned above, when there are many total subcarriers, even if it makes small the signal multiplexed number of the signal assigned to the subcarrier which is easy to be influenced by adjacent-channel-interference wave interference and the analog filter characteristic, overall transmission efficiency does not fall. However, if the signal multiplexed number of the signal assigned to the above subcarriers is made small when there are few total subcarriers, overall transmission efficiency will fall. For example, the total number of subcarriers is set to 4, and when the signal multiplexed number of the signal assigned to two subcarriers which are separated from center frequency is set to one half of the signal multiplexed numbers corresponding to other subcarriers, overall transmission efficiency falls to one fourth.

[0070]Then, in this embodiment, the signal by which multiplex will not be carried out is transmitted by the subcarrier arranged to DC by making small the signal multiplexed number of the signal assigned to a certain subcarrier.

[0071]Hereafter, the OFDM-DS-CDMA communication device concerning this embodiment is explained with reference to drawing 4 and drawing 5. Only the matter which is different from Embodiment 1 in this embodiment is explained. Drawing 4 is a mimetic diagram showing the situation of arrangement of the subcarrier in an OFDM-DS-CDMA communication device. Drawing 5 is a mimetic diagram showing the situation of arrangement of the subcarrier in the OFDM-DS-CDMA communication device concerning the embodiment of the invention 2.

[0072]When the subcarrier has been arranged to DC with reference to drawing 4, error rate characteristics deteriorate by DC offset. Since the total number of subcarriers is usually made into even number, even if it arranges a subcarrier to DC, a desired signal zone does not change. From such a reason, generally, in order to prevent degradation of error rate characteristics, to DC, a subcarrier is not arranged in many cases.

[0073]Hereafter, the subcarrier arranged to DC is explained. The case where DC offset exists is considered in a CDMA system. The DC offset after back-diffusion of gas is expressed by the formula shown below.

[Equation 1]

$$\sum_{n=1}^{N} \{DC \times REF(nT) / N\} \quad (n=1, 2, \cdots) \quad -①$$

However, DC is DC offset, REF (nT) is a spread code in the time nT, N is a diffusion ratio, and T is a sample cycle.
[0074]Here, generally, in the cycle (NT) of a spread code, since it can consider that DC offset is constant, upper type ** is expressed by the following formula.
[Equation 2]

$$DC\sum_{n=1}^{N}\{REF(nT)/N\}=DC\{(+1\text{の符号数})-(-1\text{の符号数})\}/N \qquad -②$$

[0075]In the case of (signature of 1 [+]) -(signature of 1 [-]) =1, in upper type **, DC offset is decreased by back-diffusion of gas at 1/diffusion ratio. As for DC offset, (the signature of 1 [+]) and (the signature of -1) are thoroughly removed by back-diffusion of gas, when the same. As mentioned above, in a CDMA system, degradation of the error rate by DC offset is reduced.
[0076]Therefore, in the OFDM-DS-CDMA communication device concerning this embodiment, as shown in drawing 5, a subcarrier (subcarrier #0) is arranged to DC. Hereafter, the subcarrier arranged to DC is called "DC subcarrier (DC subcarrier)."
[0077]The signal by which multiplex will not be carried out is assigned to DC subcarrier by making small the signal multiplexed number of the signal assigned to a certain subcarrier. That is, for example, in the example explained by Embodiment 1, since the signal multiplexed number of the signal assigned to the subcarrier 1 and the subcarrier m is set to k to k/2, the signal (all the k pieces) by which multiplex will not be carried out is assigned to DC subcarrier.
[0078]Thus, by transmitting a signal by which multiplex will not be carried out by making small a signal multiplexed number of a signal assigned to a certain subcarrier according to this embodiment by a subcarrier arranged to DC, Degradation of error rate characteristics can be suppressed without reducing transmission efficiency, when there are few total subcarriers.
[0079]An OFDM-DS-CDMA communication device concerning this invention can be carried in a mobile station in a digital mobile communications system, a base station device, and a communication terminal device in a wireless LAN system.
[0080]
[Effect of the Invention]As explained above, according to this invention, since the signal multiplexed number of the signal assigned to each subcarrier was set up according to the characteristic of a subcarrier (subcarrier), the OFDM-DS-CDMA communication device which reduces degradation of error rate characteristics can be provided.

TECHNICAL FIELD

[Field of the Invention]This invention about the communication apparatus used for a digital mobile communications system, Especially, It is related with the communication apparatus which performs radio of the OFDM-CDMA system which combined the CDMA (Code Division Multiple Access) method and the OFDM (Orthogonal Frequency Division Multiplexing) method.

PRIOR ART

[Description of the Prior Art]These days, communication of the OFDM-CDMA system which combined the CDMA system and the OFDM system attracts attention, and is considered briskly. This OFDM-CDMA system is mainly classified into the method (generally called the "OFDM-CDMA" method.) which arranges the signal after diffusion to a frequency direction, and the method (generally called the "OFDM-DS-CDMA" method.) which arranges the signal after diffusion to a time base direction. Hereafter, the communication apparatus (henceforth "an OFDM-DS-CDMA communication device") using an OFDM-DS-CDMA system is explained.

[0003]Drawing 6 is a block diagram showing the composition of the transmission system in the conventional OFDM-DS-CDMA communication device. Here, the total of the subcarrier (subcarrier) to be used is set to m as an example.

[0004]With reference to drawing 6, it receives for every subcarrier used as an assignment place, and k diffused parts and one adder unit are provided. Namely, to the subcarrier 1, k diffused part $601a_1$ and adder unit $602a_1$ are provided, and the subcarrier 2 is received, k diffused part $601a_2$ and adder unit $602a_2$ are provided, and k diffused part $601a_m$ and adder unit $602a_m$ are similarly provided to the subcarrier m.

[0005]k signals which consist of the signals 1 - the signals k among mk piece signals (information signal), It is considered as the signal assigned to the subcarrier 1, k signals which consist of the signals k+1 - the signals 2k are made into the signal assigned to the subcarrier 2, and k signals of the signal (m-1) k+1 - the signal mk are similarly made into the signal assigned to the subcarrier m.

[0006]k signals assigned to the subcarrier n (n=1-m) are diffused by the diffused part provided to this subcarrier, respectively. That is, the signal 1 - the signal k which are assigned to the subcarrier 1 are diffused by diffused part $601a_1$ provided to the subcarrier 1. Similarly, the signal (m-1) k+1 - the signal mk which are assigned to the subcarrier m are diffused by diffused part $601a_m$ provided to the subcarrier m. Mutually different spread code series are used in k diffused part $601a_n$ provided to the subcarrier n.

[0007]Multiplex [of the k signals diffused by diffused part $601a_n$] is carried out by adder unit $602a_n$. The total (henceforth "a signal multiplexed number") of the signal in which multiplex is carried out by adder unit $602a_n$ is set to k. The signal (henceforth a "multiple signal"), as for, multiplex was carried out by adder unit $602a_n$ is sent to the IFFT (Inverse Fast Fourier Transform) section 603.

[0008]In IFFT part 603, the IFFT (inverse Fourier transform) processing to the multiple signal from adder unit $602a_n$, i.e., Frequency-Division-Multiplexing processing, is made. The subcarrier n is assigned to the multiple signal from adder unit $602a_n$, and, specifically, Frequency-Division-Multiplexing processing is made.

[0009]How to assign a subcarrier is as being shown in drawing 8. That is, the subcarrier 1 is assigned to the multiple signal from adder unit $602a_1$, the subcarrier 2 is assigned to the multiple signal from adder unit $602a_2$, and the subcarrier m is similarly assigned to the multiple signal from adder unit $602a_m$.

[0010]By the Frequency-Division-Multiplexing processing in above IFFT parts 603, the signal with which the subcarrier was overlapped on the multiple signal from adder unit $602a_n$ is acquired.

[0011]As for the signal acquired by Frequency-Division-Multiplexing processing, a

sending signal is generated by making predetermined transmitting processing. The format of a sending signal is as being shown in drawing 9. Here, T is an OFDM symbol cycle. The situation of three OFDM symbols is shown in drawing 9. Parallel-serial-conversion processing, D/A conversion processing, frequency conversion processing, a band limiting process, etc. are included in the above-mentioned predetermined transmitting processing. This sending signal is transmitted to a communications partner via the antenna 604.
[0012]Drawing 7 is a block diagram showing the composition of the receiving system in the conventional OFDM-DS-CDMA communication device. With reference to drawing 7, k back-diffusion-of-gas parts are provided for every subcarrier. That is, k back-diffusion-of-gas part $703a_n$ is provided to the subcarrier n (n=1-m).
[0013]The signal transmitted by the communications partner is received by this communication apparatus via the antenna 701. The above-mentioned communications partner is provided with the communication apparatus shown in drawing 6.
The sending signal acquired by performing processing mentioned above is transmitted.

[0014]As for the input signal from the antenna 701, predetermined reception is made. A band limiting process, frequency conversion processing, amplification processing, A/D conversion processing, in-series parallel-conversion processing, etc. are included in the above-mentioned predetermined reception. The input signal with which the above-mentioned predetermined reception was made is sent to the FFT (Fast Fourier Transform) section 702.
[0015]In FFT section 702, the signal transmitted by each subcarrier of the subcarrier 1 - the subcarrier m is taken out by performing FFT (Fourier transform) processing to the input signal with which the above-mentioned predetermined reception was made.
[0016]Back-diffusion of gas of the signal transmitted by the subcarrier n is carried out by back-diffusion-of-gas part $703a_n$. That is, back-diffusion of gas of the signal transmitted by the subcarrier 1 is carried out by back-diffusion-of-gas part $703a_1$, and back-diffusion of gas of the signal transmitted by the subcarrier m is similarly carried out by back-diffusion-of-gas part $703a_m$. As a result, k signals which consist of the signals 1 - the signals k by back-diffusion-of-gas part $703a_1$ are extracted, and k signals which consist of the signals (m-1) k+1 - the signals mk by back-diffusion-of-gas part $703a_m$ are extracted similarly.

EFFECT OF THE INVENTION

[Effect of the Invention]By this invention, the signal multiplexed number of the signal assigned to each subcarrier was set up according to the characteristic of a subcarrier (subcarrier) to have explained above.
Therefore, the OFDM-DS-CDMA communication device which reduces degradation of error rate characteristics can be provided.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]However, in the above-mentioned conventional OFDM-DS-CDMA communication device, there is a problem that degradation of error rate characteristics becomes large as the signal transmitted for referring to drawing 8 by the subcarrier which is separated from center frequency on a center frequency axis. The cause that the error rate characteristics of the signal hereafter transmitted by the subcarrier which is separated from center frequency fall is explained.
[0018]The influence by the interference wave (henceforth "an adjacent-channel-interference wave") of an adjacent channel is mentioned [1st] first. In drawing 10, the subcarrier group 1001 shows the example of arrangement of the subcarrier used for a desired signal (desired channel). The channel which adjoins this desired channel on a frequency axis here may exist. In this case, as shown in drawing 10, the interference wave 1002, i.e., the 1st adjacent-channel-interference wave, and the 2nd adjacent-channel-interference wave 1003 of an adjoining channel may give interference to a desired channel.
[0019]In such a case, in a receiving system, the analog amplifier used at the time of amplification processing generates an unnecessary-frequencies ingredient under the influence of each above-mentioned adjacent-channel-interference wave. By this, a desired signal will be overlapped on the above-mentioned unnecessary-frequencies ingredient.
[0020]Here, the ingredient of an adjacent-channel-interference wave becomes so small that it separates from the center frequency of this adjacent channel on a frequency axis so that clearly from drawing 10. If it puts in another way, in a desired channel, the subcarrier in which the influence of an adjacent-channel-interference wave separated from the center frequency of this desired channel will become large. Therefore, in a desired signal, since the subcarrier which is more nearly separated from the center frequency of a desired channel is easy to be superimposed on an unnecessary-frequencies ingredient, the characteristic will deteriorate. As a result, in the signal transmitted by the subcarrier which is separated from center frequency on a center frequency axis, degradation of error rate characteristics becomes large.
[0021]The influence of the analog filter used [2nd] in a transmission system is mentioned. Usually, in a transmission system, in order to remove the unnecessary-frequencies ingredient of the sending signal changed into the analog signal from the digital signal, it lets this sending signal pass to an analog filter.
[0022]In drawing 11, the above-mentioned analog filter has a filter damping property which has a filter phase characteristic which is expressed by the characteristic curve 1102 to the subcarrier group 801, and is expressed by the characteristic curve 1103.
[0023]When a sending signal passes the analog filter which has the above characteristics, since the subcarrier near the cutoff frequency of a filter, i.e., the subcarrier which is separated from center frequency, is influenced by electric power attenuation, phase rotation, etc., the characteristic deteriorates. For this reason, in the signal transmitted by the subcarrier which is separated from center frequency, in a receiving system, degradation of error rate characteristics becomes large.
[0024]As mentioned above, in the conventional OFDM-DS-CDMA communication device, the error rate characteristics of the signal transmitted by the subcarrier which is separated from the center frequency of a desired signal with the characteristic of an adjacent-channel-interference wave and an analog filter deteriorate.

[0025]This invention is made in view of this point, and is a thing.
The purpose is to provide the OFDM-DS-CDMA communication device which reduces degradation of **.

MEANS

[Means for Solving the Problem]An OFDM-DS-CDMA communication device of this invention, A multiplex means to generate a multiple signal by diffusing and carrying out multiplex [of the information signal], By assigning said each multiple signal to a subcarrier peculiar to a multiple signal, a Frequency-Division-Multiplexing means to perform Frequency-Division-Multiplexing processing is provided, and said multiplex means sets up the number of information signals which carry out multiplex according to the characteristic of a subcarrier that a generated multiple signal is assigned.
[0027]According to this invention, degradation of the error rate characteristics of a signal transmitted by the above-mentioned subcarrier can be suppressed by setting up a signal multiplexed number of a signal assigned to each subcarrier according to the characteristic of each subcarrier.
[0028]As for said multiplex means, a size of influence by an adjacent-channel-interference wave in this subcarrier or a size of influence by an analog filter is used for an OFDM-DS-CDMA communication device of this invention as the characteristic of said subcarrier.
[0029]According to this invention, according to a size of influence by an adjacent-channel-interference wave in each subcarrier, and a size of influence by the analog filter characteristic, corresponding to the characteristic of each subcarrier, By setting up a signal multiplexed number of a signal assigned to each subcarrier, degradation of the error rate characteristics of a signal transmitted by the above-mentioned subcarrier can be suppressed.
[0030]As for an OFDM-DS-CDMA communication device of this invention, said multiplex means sets up small the number of said information signals which carry out multiplex compared with other multiplex means, when the characteristic of said subcarrier has deteriorated.
[0031]According to this invention, when the characteristic of a subcarrier used as an assignment place of a generated multiple signal has deteriorated, degradation of the error rate characteristics of a signal transmitted by this subcarrier can be suppressed by making small a signal multiplexed number of a signal assigned to this subcarrier compared with other subcarriers.
[0032]An OFDM-DS-CDMA communication device of this invention, When a multiplex means by which the characteristic of said subcarrier has deteriorated diffuses and carries out multiplex [of the information signal of a predetermined number] among information signals which carry out multiplex, Providing a 2nd multiplex means to generate a multiple signal instead of a multiplex means by which the characteristic of said subcarrier has deteriorated, said Frequency-Division-Multiplexing means assigns a multiple signal generated by said 2nd multiplex means to DC subcarrier.
[0033]When an information signal of a part which decreased a signal multiplexed number

and was decreased about a signal assigned to a subcarrier in which the characteristic has deteriorated assigns a signal by which multiplex was carried out to DC subcarrier according to this invention, Degradation of the error rate characteristics of a signal transmitted by each subcarrier can be suppressed preventing decline in transmission efficiency.

[0034]A communication terminal device of this invention was provided with an OFDM-DS-CDMA communication device of one of the above.

[0035]According to this invention, a communication terminal device which performs good communication can be provided by having an OFDM-DS-CDMA communication device which reduces degradation of error rate characteristics.

[0036]A base station device of this invention was provided with an OFDM-DS-CDMA communication device of one of the above.

[0037]According to this invention, a base station device which performs good communication can be provided by having an OFDM-DS-CDMA communication device which reduces degradation of error rate characteristics.

[0038]An OFDM-DS-CDMA correspondence procedure of this invention, A multiplex process of generating a multiple signal by diffusing and carrying out multiplex [of the information signal], By assigning said each multiple signal to a subcarrier peculiar to a multiple signal, a Frequency-Division-Multiplexing process of performing Frequency-Division-Multiplexing processing is provided, and said multiplex process sets up the number of information signals which carry out multiplex according to the characteristic of a subcarrier that a generated multiple signal is assigned.

[0039]According to this invention, degradation of the error rate characteristics of a signal transmitted by the above-mentioned subcarrier can be suppressed according to this invention by setting up a signal multiplexed number of a signal assigned to each subcarrier according to the characteristic of each subcarrier.

[0040]

[Embodiment of the Invention]The main point of this invention is having set up the signal multiplexed number of the signal assigned to each subcarrier according to the characteristic of a subcarrier (subcarrier).

[0041]Hereafter, an embodiment of the invention is described in detail with reference to drawings.

[0042](Embodiment 1) Drawing 1 is a block diagram showing the composition of the transmission system of the OFDM-DS-CDMA communication device concerning the embodiment of the invention 1. Drawing 2 is a block diagram showing the composition of the receiving system of the OFDM-DS-CDMA communication device concerning the embodiment of the invention 1. They shall be the subcarrier 1 - the subcarrier m about the subcarrier (subcarrier) which the OFDM-DS-CDMA communication device concerning this embodiment uses as an example here.

[0043]In the OFDM-DS-CDMA communication device concerning this embodiment, the center frequency of an adjacent-channel-interference wave may be known [and / the characteristic of the analog filter to be used]. Specifically, for example this adjacent-channel-interference wave, Interference which exceeds a predetermined threshold to the subcarrier 1 and the subcarrier m which were most separated from center frequency on the frequency axis is given (if it says conversely). The characteristic of the subcarrier 1 and a subcarrier, Assume that it has deteriorated under the influence of an adjacent-

channel-interference wave, and the above-mentioned analog filter, It shall have influence of electric power attenuation, phase rotation, etc. which exceed a predetermined threshold to the subcarry 1 and the subcarrier m (if it says conversely, the characteristic of the subcarrier 1 and the subcarrier m will be ******ed under the influence of an analog filter).

[0044]First, the transmission system of the OFDM-DS-CDMA communication device concerning this embodiment is explained with reference to drawing 1. With reference to drawing 1, it receives for every (except for the subcarrier 1 and the subcarrier m) subcarrier used as an assignment place, and k diffused parts and one adder unit are provided. However, to the subcarrier 1 and the subcarrier m used as an assignment place, k/2 diffused parts and one adder unit are provided.

[0045]That is, to the subcarrier 2, k diffused part $101a_2$ and one adder unit $102a_2$ are provided, and k diffused part $101a_{m-1}$ and one adder unit $102a_{m-1}$ are similarly provided to the subcarrier m-1. To the subcarrier 1, k/2 diffused part $101a_1$ and one adder unit $102a_1$ are provided, and k/2 diffused part $101a_m$ and one adder unit $102a_m$ are similarly provided to the subcarrier m.

[0046]k/2 which consist of signal k/[the signal 1 -] 2 among all the signals (all the information signals) signals are made into the signal assigned to the subcarrier 1, and k/2 which consist of signal k/2+1 - the signal k signals are made into the signal assigned to the subcarrier m. k signals which consist of the signals k+1 - the signals 2k among all the signals (all the information signals) are made into the signal assigned to the subcarrier 2, and k signals of the signal (m-2) k+1 - the signal (m-1) k are similarly made into the signal assigned to the subcarrier m-1.

[0047]k/2 assigned to the subcarrier j (j= 1, m) signals are diffused by the diffused part provided to this subcarrier, respectively. That is, signal k / [the signal 1 -] 2 assigned to the subcarrier 1 are diffused by diffused part $101a_1$ provided to the subcarrier 1. Similarly, signal k/2+1 assigned to the subcarrier m - the signal k are diffused by diffused part $101a_m$ provided to the subcarrier m. In k/2 provided to the subcarrier j diffused part $101a_j$, a spread code series which is mutually different is used.

[0048]k signals assigned to the subcarrier n (n= 2 to m-1) are diffused by the diffused part provided to this subcarrier, respectively. That is, the signal k+1 - the signal 2k which are assigned to the subcarrier 2 are diffused by diffused part $101a_2$ provided to the subcarrier 2. Similarly, the signal (m-2) k+1 - the signal (m-1) k which are assigned to the subcarrier m-1 are diffused by diffused part $101a_{m-1}$ provided to the subcarrier m-1. Mutually different spread code series are used in k diffused part $101a_n$ provided to the subcarrier m.

[0049]In the diffused part provided corresponding to each subcarrier, the spread code series assigned to each diffused part is a basis of the conditions of differing in other diffused parts and mutual, and how to assign the spread code series over a diffused part can be determined as follows. Namely, a common spread code series may be assigned to the diffused part provided corresponding to each subcarrier in all the subcarriers, and a peculiar spread code series may be assigned for every diffused part provided corresponding to each subcarrier. In the diffused part provided corresponding to each subcarrier, it is also possible to assign a common spread code series to the diffused part corresponding to a specific subcarrier.

[0050]Multiplex [of the k/2 diffused by diffused part $101a_j$ signals] is carried out by

adder unit $102a_j$, and multiplex [of the k signals diffused by diffused part $101a_n$] is carried out by adder unit $602a_n$. The signal multiplexed number in adder unit $102a_j$ will be k/2, and the signal multiplexed number in adder unit $102a_n$ is set to k. Namely, the interference by the adjacent-channel-interference wave which exceeds a predetermined threshold, Or a signal multiplexed number is set to k/2 [smaller than the signal multiplexed number k of other subcarriers] about the subcarrier (the subcarrier 1 and the subcarrier m) influenced by electric power attenuation, phase rotation, etc. which exceed a predetermined threshold.

[0051]The multiple signal from adder unit $102a_j$ and adder unit $102a_n$ is sent to IFFT part 103. In IFFT part 103, the IFFT (inverse Fourier transform) processing to the multiple signal from adder unit $102a_j$ and adder unit $102a_n$, i.e., Frequency-Division-Multiplexing processing, is made. The subcarrier 1 - the subcarrier m are assigned to the multiple signal from adder unit $102a_j$ and adder unit $102a_n$, and, specifically, Frequency-Division-Multiplexing processing is made.

[0052]How to assign a subcarrier is as being shown in drawing 8. That is, the subcarrier 1 is assigned to the multiple signal from adder unit $102a_1$, the subcarrier 2 is assigned to the multiple signal from adder unit $602a_2$, and the subcarrier m is similarly assigned to the multiple signal from adder unit $602a_m$.

[0053]By the Frequency-Division-Multiplexing processing in above IFFT parts 103, the signal with which the subcarrier was overlapped on the multiple signal from adder unit $102a_j$ and adder unit $102a_n$ is acquired.

[0054]As for the signal acquired by Frequency-Division-Multiplexing processing, a sending signal is generated by making predetermined transmitting processing. The format of a sending signal is as being shown in drawing 3. Here, T is an OFDM symbol cycle. The situation of three OFDM symbols is shown in drawing 3. Parallel-serial-conversion processing, D/A conversion processing, frequency conversion processing, a band limiting process, etc. are included in the above-mentioned predetermined transmitting processing. This sending signal is transmitted to a communications partner via the antenna 104.

[0055]Next, the receiving system of the OFDM-DS-CDMA communication device concerning this embodiment is explained with reference to drawing 2. With reference to drawing 2, k/2 piece or k back-diffusion-of-gas parts are provided for every subcarrier. That is, k/2 back-diffusion-of-gas part $203a_j$ is provided to the subcarrier j (j= 1, m), and k back-diffusion-of-gas part a_n is provided to the subcarrier n (n= 2 to m-1).

[0056]The signal transmitted by the communications partner is received by this communication apparatus via the antenna 201. The above-mentioned communications partner is provided with the communication apparatus shown in drawing 1, and transmits the sending signal acquired by performing processing mentioned above.

[0057]As for the input signal from the antenna 201, predetermined reception is made. A band limiting process, frequency conversion processing, amplification processing, A/D conversion processing, in-series parallel-conversion processing, etc. are included in the above-mentioned predetermined reception. The input signal with which the above-mentioned predetermined reception was made is sent to FFT section 202.

[0058]In FFT section 202, the signal transmitted by each subcarrier of the subcarrier 1 - the subcarrier m is taken out by performing FFT (Fourier transform) processing to the input signal with which the above-mentioned predetermined reception was made.

[0059]Back-diffusion of gas of the signal transmitted by the subcarrier j is carried out by

back-diffusion-of-gas part $203a_j$, and back-diffusion of gas of the signal transmitted by the subcarrier n is carried out by back-diffusion-of-gas part $203a_n$. As a result, k/2 which consist of signal k/k/2 signal and 2+1 - the signal k which consist of signal k/[the signal 1 -] 2, respectively by back-diffusion-of-gas part $203a_1$ and back-diffusion-of-gas part $203a_m$ signals are extracted. k signals which consist of the signals k+1 - the signals 2k by back-diffusion-of-gas part $203a_2$ are extracted, and k signals which consist of the signals (m-2) k+1 - the signals (m-1) k by back-diffusion-of-gas part $203a_{m-1}$ are extracted similarly.

[0060]The subcarrier in which interference by an adjacent-channel-interference wave exceeds a predetermined threshold so that clearly from the above explanation, And the influence of electric power attenuation, phase rotation, etc. by an analog filter makes small the signal multiplexed number of the signal assigned to this subcarrier about the subcarrier (namely, subcarrier generally separated from the center frequency of the desired signal on the frequency axis) which exceeds a predetermined threshold. For example, as a signal multiplexed number of the signal assigned to the subcarrier 1 and the subcarrier m, it replaces with the signal multiplexed number k of the signal assigned to other subcarriers, and k/2 is used.

[0061]Generally, in an OFDM-DS-CDMA system, degradation of the error rate characteristics in a receiving system can be suppressed by making a signal multiplexed number small. Therefore, the demodulation signal acquired by the back-diffusion-of-gas processing to the signal transmitted by the subcarrier 1 and the subcarrier m turns into a signal with good error rate characteristics.

[0062]Here, although the transmission efficiency of these subcarriers falls by having made small the signal multiplexed number of the signal assigned to the subcarrier 1 and the subcarrier m, when there are many total subcarriers, the decline in overall transmission efficiency will become [few]. For example, when the total number of subcarriers is set to 32 and the signal multiplexed number of the signal assigned to two subcarriers most separated from center frequency on the frequency axis is set to one half, it is only that the whole transmission efficiency falls about 3%.

[0063]Although the case where the center frequency of an adjacent-channel-interference wave was known was explained so far, This invention can be applied also when a signal level, a phase, etc. of the case where the center frequency and the signal level of an adjacent-channel-interference wave are not known, and an adjacent-channel-interference wave change with phasing etc. In this case, the influence of adjacent-channel-interference wave interference etc. should just make small the signal multiplexed number of the signal which detects the subcarrier which exceeds a predetermined threshold and assigns it to the detected subcarrier among all the subcarriers.

[0064]Thus, the subcarrier which is easy to be influenced by adjacent-channel-interference wave interference and the analog filter characteristic among all the subcarriers according to this embodiment (especially) Degradation of the error rate characteristics of the signal transmitted by the above-mentioned subcarrier can be suppressed by making smaller than the signal multiplexed number of the signal assigned to other subcarriers the signal multiplexed number of the signal assigned to the subcarrier which is separated from the center frequency of a desired signal. According to the characteristic of each subcarrier, i.e., the size of the influence by an adjacent-channel-interference wave [in / for example, / each subcarrier] and the size of the influence by

the analog filter characteristic, if it puts in another way, By setting up the number of multiple signals of the signal assigned to each subcarrier, degradation of the error rate characteristics of the signal transmitted by the above-mentioned subcarrier can be suppressed.

[0065]Although the case where the signal multiplexed number of the signal assigned to the subcarrier which is easy to receive the influence of an adjacent-channel-interference wave and the influence of the analog filter characteristic in this embodiment was set to one half of the signal multiplexed numbers of the signal assigned to other subcarriers was explained, This invention is not limited to this but can be applied also to the case where a signal multiplexed number is set up, for every above-mentioned subcarrier according to an adjacent-channel-interference wave, the size of the influence of an analog filter, etc. Thereby, when the influence of adjacent-channel-interference wave interference and the analog filter characteristic is different for every subcarrier, degradation of error rate characteristics can be suppressed.

[0066]In this embodiment, the still more nearly following effects are acquired by making small the signal multiplexed number of the signal assigned to the subcarrier separated from center frequency on the frequency axis. That is, in an OFDM system, an OFDM-CDMA system, and an OFDM-DS-CDMA system, an unnecessary-frequencies ingredient occurs by the side lobe component of each subcarrier in a certain desired signal. The unnecessary-frequencies ingredient by the side lobe component of the subcarrier which is separated from center frequency among the unnecessary-frequencies ingredients by each of these subcarriers is based on this desired signal, and also it turns into an interferent component to a channel.

[0067]Here, in this embodiment, the signal level of the subcarrier which made the signal multiplexed number small can be made small. That is, the signal level of the subcarrier which is separated from center frequency can be made small. Thereby, this desired signal can also reduce interference given to other channels.

[0068](Embodiment 2) By this embodiment, in Embodiment 1, when there are few total subcarriers, the case where it is made not to reduce transmission efficiency is explained.

[0069]In Embodiment 1 mentioned above, when there are many total subcarriers, even if it makes small the signal multiplexed number of the signal assigned to the subcarrier which is easy to be influenced by adjacent-channel-interference wave interference and the analog filter characteristic, overall transmission efficiency does not fall. However, if the signal multiplexed number of the signal assigned to the above subcarriers is made small when there are few total subcarriers, overall transmission efficiency will fall. For example, the total number of subcarriers is set to 4, and when the signal multiplexed number of the signal assigned to two subcarriers which are separated from center frequency is set to one half of the signal multiplexed numbers corresponding to other subcarriers, overall transmission efficiency falls to one fourth.

[0070]Then, in this embodiment, the signal by which multiplex will not be carried out is transmitted by the subcarrier arranged to DC by making small the signal multiplexed number of the signal assigned to a certain subcarrier.

[0071]Hereafter, the OFDM-DS-CDMA communication device concerning this embodiment is explained with reference to drawing 4 and drawing 5. Only the matter which is different from Embodiment 1 in this embodiment is explained. Drawing 4 is a mimetic diagram showing the situation of arrangement of the subcarrier in an OFDM-

DS-CDMA communication device. Drawing 5 is a mimetic diagram showing the situation of arrangement of the subcarrier in the OFDM-DS-CDMA communication device concerning the embodiment of the invention 2.

[0072]When the subcarrier has been arranged to DC with reference to drawing 4, error rate characteristics deteriorate by DC offset. Since the total number of subcarriers is usually made into even number, even if it arranges a subcarrier to DC, a desired signal zone does not change. From such a reason, generally, in order to prevent degradation of error rate characteristics, to DC, a subcarrier is not arranged in many cases.

[0073]Hereafter, the subcarrier arranged to DC is explained. The case where DC offset exists is considered in a CDMA system. The DC offset after back-diffusion of gas is expressed by the formula shown below.

[Equation 1]

$$\sum_{n=1}^{N}\{DC \times REF(nT)/N\} \quad (n=1, 2, \cdots) \quad -①$$

However, DC is DC offset, REF (nT) is a spread code in the time nT, N is a diffusion ratio, and T is a sample cycle.

[0074]Here, generally, in the cycle (NT) of a spread code, since it can consider that DC offset is constant, upper type ** is expressed by the following formula.

[Equation 2]

$$DC\sum_{n=1}^{N}(REF(nT)/N)=DC\{(+1の符号数)-(-1の符号数)\}/N \quad -②$$

[0075]In the case of (signature of 1 [+]) -(signature of 1 [-]) =1, in upper type **, DC offset is decreased by back-diffusion of gas at 1/diffusion ratio. As for DC offset, (the signature of 1 [+]) and (the signature of -1) are thoroughly removed by back-diffusion of gas, when the same. As mentioned above, in a CDMA system, degradation of the error rate by DC offset is reduced.

[0076]Therefore, in the OFDM-DS-CDMA communication device concerning this embodiment, as shown in drawing 5, a subcarrier (subcarrier #0) is arranged to DC. Hereafter, the subcarrier arranged to DC is called "DC subcarrier (DC subcarrier)."

[0077]The signal by which multiplex will not be carried out is assigned to DC subcarrier by making small the signal multiplexed number of the signal assigned to a certain subcarrier. That is, for example, in the example explained by Embodiment 1, since the signal multiplexed number of the signal assigned to the subcarrier 1 and the subcarrier m is set to k to k/2, the signal (all the k pieces) by which multiplex will not be carried out is assigned to DC subcarrier.

[0078]Thus, by transmitting a signal by which multiplex will not be carried out by making small a signal multiplexed number of a signal assigned to a certain subcarrier according to this embodiment by a subcarrier arranged to DC, Degradation of error rate characteristics can be suppressed without reducing transmission efficiency, when there are few total subcarriers.

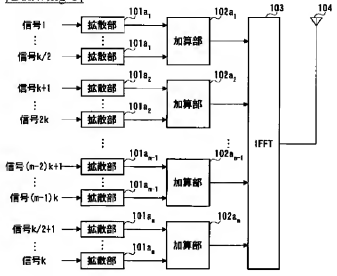
[0079]An OFDM-DS-CDMA communication device concerning this invention can be carried in a mobile station in a digital mobile communications system, a base station device, and a communication terminal device in a wireless LAN system.

DESCRIPTION OF DRAWINGS

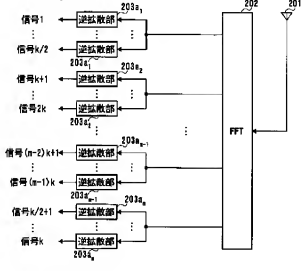
[Brief Description of the Drawings]
[Drawing 1]The block diagram showing the composition of the transmission system of the OFDM-DS-CDMA communication device concerning the embodiment of the invention 1
[Drawing 2]The block diagram showing the composition of the receiving system of the OFDM-DS-CDMA communication device concerning the embodiment of the invention 1
[Drawing 3]The mimetic diagram showing the format of the sending signal in the OFDM-DS-CDMA communication device concerning the embodiment of the invention 1
[Drawing 4]The mimetic diagram showing the situation of arrangement of the subcarrier in an OFDM-DS-CDMA communication device
[Drawing 5]The mimetic diagram showing the situation of arrangement of the subcarrier in the OFDM-DS-CDMA communication device concerning the embodiment of the invention 2
[Drawing 6]The block diagram showing the composition of the transmission system in the conventional OFDM-DS-CDMA communication device
[Drawing 7]The block diagram showing the composition of the receiving system in the conventional OFDM-DS-CDMA communication device
[Drawing 8]The mimetic diagram showing an example of the situation of arrangement of the subcarrier in an OFDM-DS-CDMA communication device
[Drawing 9]The mimetic diagram showing the format of the sending signal in the conventional OFDM-DS-CDMA communication device
[Drawing 10]The mimetic diagram showing the situation of the influence by the adjacent-channel-interference wave in the conventional OFDM-DS-CDMA communication device
[Drawing 11]The mimetic diagram showing the influence by the analog filter in the conventional OFDM-DS-CDMA communication device
[Description of Notations]
$101a_1$ - a $101a_m$ diffused part
$102a_1$ - a $102a_m$ adder unit
103 IFFT part
104 Antenna

DRAWINGS

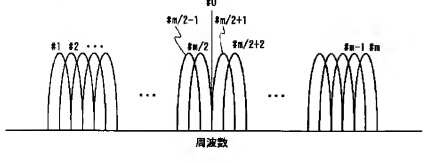
[Drawing 1]



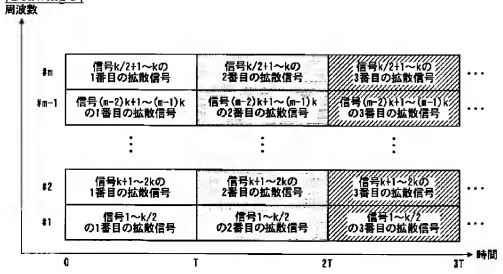
[Drawing 2]



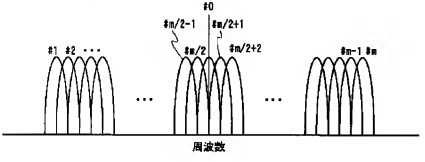
[Drawing 4]



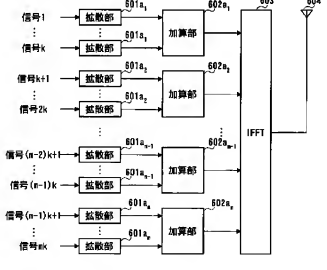
[Drawing 3]



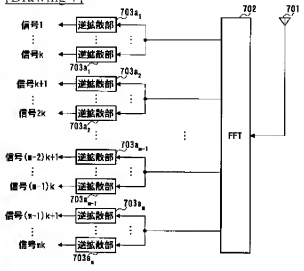
[Drawing 5]



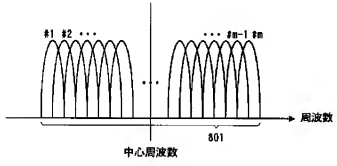
[Drawing 6]



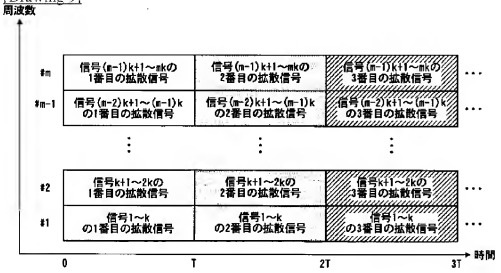
[Drawing 7]



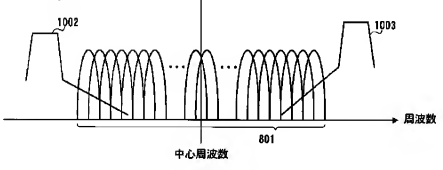
[Drawing 8]



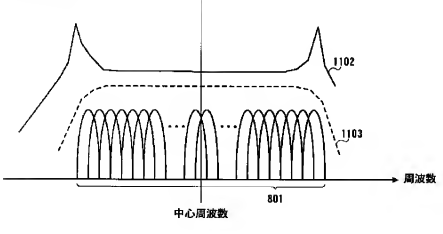
[Drawing 9]



[Drawing 10]



[Drawing 11]



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Ｈ０４Ｂ　1/707		13/00	Ｄ	

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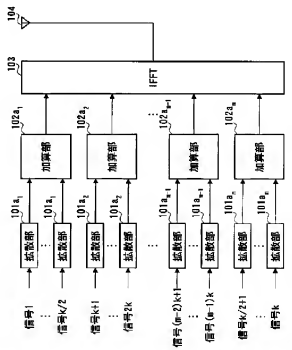
Ｆターム(参考)　５Ｋ０２２ ＤＤ０１ ＤＤ１３ ＤＤ１９ ＤＤ２２ ＤＤ２３
ＤＤ３３ ＥＥ０２ ＥＥ２２ ＦＦ０１

(54)【発明の名称】　ＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置

(57)【要約】
【課題】　誤り率特性の劣化を低減させること。
【解決手段】　加算部１０２a_1および加算部１０２a_aは、拡散されたｋ／２個の情報信号を多重することにより、多重信号を生成する。加算部１０２a_2～加算部１０２a_{a-1}は、拡散されたｋ個の情報信号を多重することにより、多重信号を生成する。ＩＦＦＴ部１０３は、特性の劣化しているサブキャリア１およびサブキャリアｍに対して、それぞれ、加算部１０２a_1からの多重信号および加算部１０２a_aからの多重信号を割り当て、特性の良好なサブキャリア２～サブキャリアｍ－１に対しては、それぞれ、加算部１０２a_2～加算部１０２a_{a-1}からの多重信号を割り当てて、周波数分割多重処理を行う。



【特許請求の範囲】

【請求項１】　情報信号を拡散して多重することにより多重信号を生成する多重手段と、前記各多重信号を多重信号固有の搬送波に割り当てることにより周波数分割多重処理を行う周波数分割多重手段と、を具備し、前記多重手段は、生成した多重信号が割り当てられる搬送波の特性に応じて、多重する情報信号の数を設定することを特徴とするＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置。

【請求項２】　前記多重手段は、前記搬送波の特性として、この搬送波における隣接チャネル干渉波による影響の大きさまたはアナログフィルタによる影響の大きさを用いることを特徴とする請求項１に記載のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置。

【請求項３】　前記多重手段は、前記搬送波の特性が劣化している場合には、他の多重手段に比べて前記多重する情報信号の数を小さく設定することを特徴とする請求項１または請求項２に記載のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置。

【請求項４】　前記搬送波の特性が劣化している多重手段が多重する情報信号のうち、所定数の情報信号を拡散して多重することにより、前記搬送波の特性が劣化している多重手段に代わり多重信号を生成する第２多重手段を具備し、前記周波数分割多重手段は、前記第２多重手段により生成された多重信号をＤＣ搬送波に割り当てることを特徴とする請求項１から請求項３のいずれかに記載のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置。

【請求項５】　請求項１から請求項４のいずれかに記載のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置を備えたことを特徴とする通信端末装置。

【請求項６】　請求項１から請求項４のいずれかに記載のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置を備えたことを特徴とする基地局装置。

【請求項７】　情報信号を拡散して多重することにより多重信号を生成する多重工程と、前記各多重信号を多重信号固有の搬送波に割り当てることにより周波数分割多重処理を行う周波数分割多重工程と、を具備し、前記多重工程は、生成した多重信号が割り当てられる搬送波の特性に応じて、多重する情報信号の数を設定することを特徴とするＯＦＤＭ－ＤＳ－ＣＤＭＡ通信方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、ディジタル移動体通信システムに用いられる通信装置に関し、特に、ＣＤＭＡ（Ｃｏｄｅ　Ｄｉｖｉｓｉｏｎ　Ｍｕｌｔｉｐｌｅ　Ａｃｃｅｓｓ）方式とＯＦＤＭ（Ｏｒｔｈｏｇｏｎａｌ　Ｆｒｅｑｕｅｎｃｙ　Ｄｉｖｉｓｉｏｎ　Ｍｕｌｔｉｐｌｅｘｉｎｇ）方式を組み合わせたＯＦＤＭ－ＣＤＭＡ方式の無線通信を行う通信装置に関する。

【０００２】

【従来の技術】最近、ＣＤＭＡ方式とＯＦＤＭ方式とを組み合わせたＯＦＤＭ－ＣＤＭＡ方式の通信が、注目され盛んに検討されている。このＯＦＤＭ－ＣＤＭＡ方式は、主に、拡散後の信号を周波数方向に配置する方式（一般に「ＯＦＤＭ－ＣＤＭＡ」方式と呼ばれている。）と、拡散後の信号を時間軸方向に配置する方式（一般に「ＯＦＤＭ－ＤＳ－ＣＤＭＡ」方式と呼ばれている。）に分類される。以下、ＯＦＤＭ－ＤＳ－ＣＤＭＡ方式を用いた通信装置（以下「ＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置」という。）について説明する。

【０００３】図６は、従来のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置における送信系の構成を示すブロック図である。ここでは、一例として、用いるサブキャリア（搬送波）の総数をｍとする。

【０００４】図６を参照するに、割り当て先となるサブキャリア毎に対して、ｋ個の拡散部およびｋ個の加算部が設けられている。すなわち、サブキャリア１に対しては、ｋ個の拡散部６０１ａ１および加算部６０２ａ１が設けられ、サブキャリア２に対しては、ｋ個の拡散部６０１ａ２および加算部６０２ａ２が設けられ、同様に、サブキャリアｍに対しては、ｋ個の拡散部６０１ａｍおよび加算部６０２ａｍが設けられている。

【０００５】ｍｋ個の信号（情報信号）のうち、信号１～信号ｋからなるｋ個の信号は、サブキャリア１に割り当てられる信号とされ、信号ｋ＋１～信号２ｋからなるｋ個の信号は、サブキャリア２に割り当てられる信号とされ、同様に、信号（ｍ－１）ｋ＋１～信号ｍｋのｋ個の信号は、サブキャリアｍに割り当てられる信号とされる。

【０００６】サブキャリアｎ（ｎ＝１～ｍ）に割り当てられるｋ個の信号は、それぞれ、このサブキャリアに対して設けられた拡散部により拡散される。すなわち、サブキャリア１に割り当てられる信号１～信号ｋは、サブキャリア１に対して設けられた拡散部６０１ａ１により拡散される。同様に、サブキャリアｍに割り当てられる信号（ｍ－１）ｋ＋１～信号ｍｋは、サブキャリアｍに対して設けられた拡散部６０１ａｍにより拡散される。なお、サブキャリアｎに対して設けられたｋ個の拡散部６０１ａｎでは、相互に異なる拡散符号系列が用いられている。

【０００７】拡散部６０１ａｎにより拡散されたｋ個の信号は、加算部６０２ａｎにより多重される。加算部６０２ａｎにより多重される信号の総数（以下「信号多重数」という。）は、ｋとなる。加算部６０２ａｎにより多重された信号（以下「多重信号」という。）は、ＩＦＦＴ（Ｉｎｖｅｒｓｅ　Ｆａｓｔ　Ｆｏｕｒｉｅｒ　Ｔｒａｎｓｆｏｒｍ）部６０３に送られる。

【０００８】ＩＦＦＴ部６０３では、加算部６０２ａｎからの多重信号に対するＩＦＦＴ（逆フーリエ変換）処理、すなわち、周波数分割多重処理がなされる。具体的には、加算部６０２ａｎからの多重信号にはサブキャリ

アｎが割り当てられて、周波数分割多重処理がなされる。

【０００９】サブキャリアの割り当て方法は、図８に示す通りである。すなわち、加算部６０２a_1からの多重信号にはサブキャリア１が割り当てられ、加算部６０２a_2からの多重信号にはサブキャリア２が割り当てられ、同様に、加算部６０２a_nからの多重信号にはサブキャリアｍが割り当てられる。

【００１０】上記のようなＩＦＦＴ部６０３における周波数分割多重処理により、加算部６０２a_nからの多重信号がサブキャリアに重畳された信号が得られる。

【００１１】周波数分割多重処理により得られた信号は、所定の送信処理がなされることにより、送信信号が生成される。送信信号のフォーマットは、図９に示す通りである。ここで、ＴはＯＦＤＭシンボル周期である。図９には、３つのＯＦＤＭシンボルの様子が示されている。なお、上記所定の送信処理には、並列直列変換処理、Ｄ／Ａ変換処理、周波数変換処理および帯域制限処理等が含まれる。この送信信号は、アンテナ６０４を介して通信相手に対して送信される。

【００１２】図７は、従来のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置における受信系の構成を示すブロック図である。図７を参照すると、サブキャリア毎にｋ個の逆拡散部が設けられている。すなわち、サブキャリアｎ（ｎ＝１～ｍ）に対して、ｋ個の逆拡散部７０３a_1が設けられている。

【００１３】通信相手により送信された信号は、アンテナ７０１を介して、本通信装置により受信される。なお、上記通信相手は、図６に示した通信装置を備えており、上述した処理を行うことにより得られた送信信号を送信するものである。

【００１４】アンテナ７０１からの受信信号は、所定の受信処理がなされる。なお、上記所定の受信処理には、帯域制限処理、周波数変換処理、増幅処理、Ａ／Ｄ変換処理および直列並列変換処理等が含まれる。上記所定の受信処理がなされた受信信号は、ＦＦＴ（Ｆａｓｔ　Ｆｏｕｒｉｅｒ　Ｔｒａｎｓｆｏｒｍ）部７０２に送られる。

【００１５】ＦＦＴ部７０２では、上記所定の受信処理がなされた受信信号に対するＦＦＴ（フーリエ変換）処理が行われることにより、サブキャリア１～サブキャリアｍの各サブキャリアにより伝送された信号が取り出される。

【００１６】サブキャリアｎにより伝送された信号は、逆拡散部７０３a_nにより逆拡散される。すなわち、サブキャリア１により伝送された信号は、逆拡散部７０３a_1により逆拡散され、同様に、サブキャリアｍにより伝送された信号は、逆拡散部７０３a_nにより逆拡散される。この結果、逆拡散部７０３a_1により信号１～信号ｋからなるｋ個の信号が抽出され、同様に、逆拡散部７０３a_nにより信号（ｍ－１）ｋ＋１～信号ｍｋからなるｋ個の信号が抽出される。

【００１７】

【発明が解決しようとする課題】しかしながら、上記従来のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置においては、図８を参照するに、中心周波数軸上において中心周波数から離れたサブキャリアにより伝送された信号ほど、誤り率特性の劣化が大きくなるという問題がある。以下、中心周波数から離れたサブキャリアにより伝送された信号の誤り率特性が低下する原因について説明する。

【００１８】まず第１に、隣接チャネル干渉波（以下「隣接チャネル干渉波」という。）による影響が挙げられる。図１０において、サブキャリア群１００１は、希望信号（希望チャネル）に用いられるサブキャリアの配置例を示したものである。ここで、周波数軸上において、この希望チャネルに隣接するチャネルが存在する場合がある。この場合には、図１０に示すように、隣接するチャネルの干渉波、すなわち、第１隣接チャネル干渉波１００２および第２隣接チャネル干渉波１００３が、希望チャネルに干渉を与えることがある。

【００１９】このような場合には、受信系においては、増幅処理時に用いられるアナログ増幅器は、上記各隣接チャネル干渉波の影響により、不要周波数成分を発生させる。これにより、希望信号には、上記不要周波数成分が重畳されることになる。

【００２０】ここで、図１０から明らかなように、隣接チャネル干渉波の成分は、周波数軸上において、この隣接チャネルの中心周波数から離れるほど小さくなる。換言すれば、希望チャネルにおいては、隣接チャネル干渉波の影響は、この希望チャネルの中心周波数から離れたサブキャリアほど大きくなる。したがって、希望信号においては、希望チャネルの中心周波数から離れたサブキャリアほど、不要周波数成分が重畳されやすいので、特性が劣化することになる。この結果、中心周波数軸上において中心周波数から離れたサブキャリアにより伝送された信号ほど、誤り率特性の劣化が大きくなる。

【００２１】第２に、送信系において用いられるアナログフィルタの影響が挙げられる。通常、送信系においては、ディジタル信号からアナログ信号に変換した送信信号の不要周波数成分を除去するために、この送信信号をアナログフィルタに通す。

【００２２】図１１において、上記アナログフィルタは、サブキャリア群８０１に対して、特性曲線１１０２により表現されるようなフィルタ位相特性を有し、また、特性曲線１１０３により表現されるようなフィルタ減衰特性を有する。

【００２３】送信信号が上記のような特性を有するアナログフィルタを通過した場合には、フィルタの遮断周波数に近いサブキャリア、すなわち中心周波数から離れたサブキャリアは、電力減衰や位相回転等の影響を受ける

ので、特性が劣化する。このため、受信系においては、中心周波数から離れたサブキャリアにより伝送された信号ほど、誤り率特性の劣化が大きくなる。

【００２４】以上のように、従来のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置においては、隣接チャネル干渉波およびアナログフィルタの特性により、希望信号の中心周波数から離れたサブキャリアにより伝送された信号の誤り率特性が劣化する。

【００２５】本発明は、かかる点に鑑みてなされたものであり、誤り率特性の劣化を低減させるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置を提供することを目的とする。

【００２６】

【課題を解決するための手段】本発明のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置は、情報信号を拡散して多重することにより多重信号を生成する多重手段と、前記各多重信号を多重信号固有の搬送波に割り当てることにより周波数分割多重処理を行う周波数分割多重手段と、を具備し、前記多重手段は、生成した多重信号が割り当てられる搬送波の特性に応じて、多重する情報信号の数を設定することを特徴とする。

【００２７】本発明によれば、各搬送波の特性に応じて、各搬送波に割り当てる信号の信号多重数を設定することにより、上記搬送波により伝送された信号の誤り率特性の劣化を抑えることができる。

【００２８】本発明のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置は、前記多重手段は、前記搬送波の特性として、この搬送波における隣接チャネル干渉による影響の大きさまたはアナログフィルタによる影響の大きさを用いることを特徴とする。

【００２９】本発明によれば、各搬送波の特性に応じて、すなわち、各搬送波における隣接チャネル干渉波による影響の大きさおよびアナログフィルタ特性による影響の大きさに応じて、各搬送波に割り当てる信号の信号多重数を設定することにより、上記搬送波により伝送された信号の誤り率特性の劣化を抑えることができる。

【００３０】本発明のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置は、前記多重手段は、前記搬送波の特性が劣化している場合には、他の多重手段に比べて前記多重する情報信号の数を小さく設定することを特徴とする。

【００３１】本発明によれば、生成した多重信号の割り当て先となる搬送波の特性が劣化している場合には、この搬送波に割り当てる信号の信号多重数を他の搬送波に比べて小さくすることにより、この搬送波により伝送される信号の誤り率特性の劣化を抑えることができる。

【００３２】本発明のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置は、前記搬送波の特性が劣化している多重手段が多重する情報信号のうち、所定数の情報信号を拡散して多重することにより、前記搬送波の特性が劣化している多重手段に代わり多重信号を生成する第２多重手段を具備し、前記周波数分割多重手段は、前記第２多重手段により生成された多重信号をＤＣ搬送波に割り当てることを特徴とする。

【００３３】本発明によれば、特性が劣化している搬送波に割り当てる信号については信号多重数を減少させ、減少させた分の情報信号が多重された信号をＤＣ搬送波に割り当てることにより、伝送効率の低下を防ぎつつ、各搬送波により伝送される信号の誤り率特性の劣化を抑えることができる。

【００３４】本発明の通信端末装置は、上記いずれかのＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置を備えたことを特徴とする。

【００３５】本発明によれば、誤り率特性の劣化を低減させるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置を備えることにより、良好な通信を行う通信端末装置を提供することができる。

【００３６】本発明の基地局装置は、上記いずれかのＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置を備えたことを特徴とする。

【００３７】本発明によれば、誤り率特性の劣化を低減させるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置を備えることにより、良好な通信を行う基地局装置を提供することができる。

【００３８】本発明のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信方法は、情報信号を拡散して多重することにより多重信号を生成する多重工程と、前記各多重信号を多重信号固有の搬送波に割り当てることにより周波数分割多重処理を行う周波数分割多重工程と、を具備し、前記多重工程は、生成した多重信号が割り当てられる搬送波の特性に応じて、多重する情報信号の数を設定することを特徴とする。

【００３９】本発明によれば、本発明によれば、各搬送波の特性に応じて、各搬送波に割り当てる信号の信号多重数を設定することにより、上記搬送波により伝送された信号の誤り率特性の劣化を抑えることができる。

【００４０】

【発明の実施の形態】本発明の骨子は、搬送波（サブキャリア）の特性に応じて、各搬送波に割り当てられる信号の信号多重数を設定するようにしたことである。

【００４１】以下、本発明の実施の形態について、図面を参照して詳細に説明する。

【００４２】（実施の形態１）図１は、本発明の実施の形態１にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置の送信系の構成を示すブロック図である。図２は、本発明の実施の形態１にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置の受信系の構成を示すブロック図である。ここでは、一例として、本実施の形態にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置が用いるサブキャリア（搬送波）をサブキャリア１～サブキャリアｍであるものとする。

【００４３】また、本実施の形態にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置においては、隣接チャネル干渉波

の中心周波数は既知なものであり、用いるアナログフィルタの特性も既知なものであるとする。具体的には、例えば、この隣接チャネル干渉波は、中心周波数から周波数軸上最も離れたサブキャリア１およびサブキャリアｍに対して所定のしきい値を上回る干渉を与えている（逆に言えば、サブキャリア１およびサブキャリアの特性は、隣接チャネル干渉波の影響により劣化している）ものとし、上記アナログフィルタは、サブキャリア１およびサブキャリアｍに対して所定のしきい値を上回る電力減衰や位相回転等の影響を与える（逆に言えば、サブキャリア１およびサブキャリアｍの特性は、アナログフィルタの影響により劣化している）ものとする。

【００４４】まず、本実施の形態にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置の送信系について、図１を参照して説明する。図１を参照するに、割り当て先となるサブキャリア毎（サブキャリア１およびサブキャリアｍを除く）に対して、ｋ個の拡散部および１個の加算部が設けられている。ただし、割り当て先となるサブキャリア１およびサブキャリアｍに対しては、ｋ／２個の拡散部および１個の加算部が設けられている。

【００４５】すなわち、サブキャリア２に対しては、ｋ個の拡散部１０１ａ$_2$および１個の加算部１０２ａ$_2$が設けられ、同様に、サブキャリアｍ－１に対しては、ｋ個の拡散部１０１ａ$_{m-1}$および１個の加算部１０２ａ$_{m-1}$が設けられている。また、サブキャリア１に対しては、ｋ／２個の拡散部１０１ａ$_1$および１個の加算部１０２ａ$_1$が設けられ、同様に、サブキャリアｍに対しては、ｋ／２個の拡散部１０１ａ$_m$および１個の加算部１０２ａ$_m$が設けられている。

【００４６】全信号（全情報信号）のうち、信号１～信号ｋ／２からなるｋ／２個の信号は、サブキャリア１に割り当てられる信号とされ、信号ｋ／２＋１～信号ｋからなるｋ／２個の信号は、サブキャリアｍに割り当てられる信号とされる。また、全信号（全情報信号）のうち、信号ｋ＋１～信号２ｋからなるｋ個の信号は、サブキャリア２に割り当てられる信号とされ、同様に、信号（ｍ－２）ｋ＋１～信号（ｍ－１）ｋの信号は、サブキャリアｍ－１に割り当てられる信号とされる。

【００４７】サブキャリアｊ（ｊ＝１，ｍ）に割り当てられるｋ／２個の信号は、それぞれ、このサブキャリアに対して設けられた拡散部により拡散される。すなわち、サブキャリア１に割り当てられる信号１～信号ｋ／２は、サブキャリア１に対して設けられた拡散部１０１ａ$_1$により拡散される。同様に、サブキャリアｍに割り当てられる信号ｋ／２＋１～信号ｋは、サブキャリアｍに対して設けられた拡散部１０１ａ$_m$により拡散される。なお、サブキャリアｊに対して設けられたｋ／２個の拡散部１０１ａ$_j$では、相互に異なる拡散符号系列が用いられている。

【００４８】サブキャリアｎ（ｎ＝２～ｍ－１）に割り当てられるｋ個の信号は、それぞれ、このサブキャリアに対して設けられた拡散部により拡散される。すなわち、サブキャリア２に割り当てられる信号ｋ＋１～信号２ｋは、サブキャリア２に対して設けられた拡散部１０１ａ$_2$により拡散される。同様に、サブキャリアｍ－１に割り当てられる信号（ｍ－２）ｋ＋１～信号（ｍ－１）ｋは、サブキャリアｍ－１に対して設けられた拡散部１０１ａ$_{m-1}$により拡散される。なお、サブキャリアｍに対して設けられたｋ個の拡散部１０１ａ$_n$では、相互に異なる拡散符号系列が用いられている。

【００４９】なお、拡散部に対する拡散符号系列の割り当て方は、各サブキャリアに対応して設けられた拡散部において、各拡散部に割り当てる拡散符号系列が、その他の拡散部と相互に異なるという条件のもとで、以下のように決定することができる。すなわち、各サブキャリアに対応して設けられた拡散部に、全サブキャリアにおいて共通の拡散符号系列を割り当ててもよいし、各サブキャリアに対応して設けられた拡散部毎に、固有の拡散符号系列を割り当ててもよい。さらに、各サブキャリアに対応して設けられた拡散部において、特定のサブキャリアに対応する拡散部に、共通の拡散符号系列を割り当てることも可能である。

【００５０】拡散部１０１ａ$_j$により拡散されたｋ／２個の信号は、加算部１０２ａ$_j$により多重され、拡散部１０１ａ$_n$により拡散されたｋ個の信号は、加算部６０２ａ$_n$により多重される。加算部１０２ａ$_j$における信号多重数はｋ／２となり、加算部１０２ａ$_n$における信号多重数はｋとなる。すなわち、所定のしきい値を上回る隣接チャネル干渉波による干渉、または所定のしきい値を上回る電力減衰や位相回転等の影響を受けるサブキャリア（サブキャリア１およびサブキャリアｍ）については、信号多重数は、その他のサブキャリアの信号多重数よより小さいｋ／２とされる。

【００５１】加算部１０２ａ$_j$および加算部１０２ａ$_n$からの多重信号は、ＩＦＦＴ部１０３に送られる。ＩＦＦＴ部１０３では、加算部１０２ａ$_j$および加算部１０２ａ$_n$からの多重信号に対するＩＦＦＴ（逆フーリエ変換）処理、すなわち、周波数分割多重処理がなされる。具体的には、加算部１０２ａ$_j$および加算部１０２ａ$_n$からの多重信号には、サブキャリア１～サブキャリアｍが割り当てられて、周波数分割多重処理が施される。

【００５２】サブキャリアの割り当て方法は、図８に示す通りである。すなわち、加算部１０２ａ$_1$からの多重信号にはサブキャリア１が割り当てられ、加算部６０２ａ$_2$からの多重信号にはサブキャリア２が割り当てられ、同様に、加算部６０２ａ$_n$からの多重信号にはサブキャリアｍが割り当てられる。

【００５３】上記のようなＩＦＦＴ部１０３における周波数分割多重処理により、加算部１０２ａ$_j$および加算部１０２ａ$_n$からの多重信号がサブキャリアに重畳され

た信号が得られる。

【００５４】周波数分割多重処理により得られた信号は、所定の送信処理が施されることにより、送信信号が生成される。送信信号のフォーマットは、図３に示す通りである。ここで、ＴはＯＦＤＭシンボル周期である。図３には、３つのＯＦＤＭシンボルの様子が示されている。なお、上記所定の送信処理には、並列直列変換処理、Ｄ／Ａ変換処理、周波数変換処理および帯域制限処理等が含まれる。この送信信号は、アンテナ１０４を介して通信相手に対して送信される。

【００５５】次に、本実施の形態にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置の受信系について、図２を参照して説明する。図２を参照するに、サブキャリア毎にｋ／２個またはｋ個の逆拡散部が設けられている。すなわち、サブキャリアｊ（ｊ＝１，ｍ）に対して、ｋ／２個の逆拡散部２０３ａ$_j$が設けられ、サブキャリアｎ（ｎ＝２～ｍ－１）に対して、ｋ個の逆拡散部ａ$_n$が設けられている。

【００５６】通信相手により送信された信号は、アンテナ２０１を介して、本通信装置により受信される。なお、上記通信相手は、図１に示した通信装置を備えており、上述した処理を行うことにより得られた送信信号を送信するものである。

【００５７】アンテナ２０１からの受信信号は、所定の受信処理がなされる。なお、上記所定の受信処理には、帯域制限処理、周波数変換処理、増幅処理、Ａ／Ｄ変換処理および直列並列変換処理等が含まれる。上記所定の受信処理がなされた受信信号は、ＦＦＴ部２０２に送られる。

【００５８】ＦＦＴ部２０２では、上記所定の受信処理がなされた受信信号に対するＦＦＴ（フーリエ変換）処理が行われることにより、サブキャリア１～サブキャリアｍの各サブキャリアにより伝送された信号が取り出される。

【００５９】サブキャリアｊにより伝送された信号は、逆拡散部２０３ａ$_j$により逆拡散され、サブキャリアｎにより伝送された信号は、逆拡散部２０３ａ$_n$により逆拡散される。この結果、逆拡散部２０３ａ$_1$および逆拡散部２０３ａ$_m$により、それぞれ、信号１～信号ｋ／２からなるｋ／２個の信号および信号ｋ／２＋１～信号ｋからなるｋ／２個の信号が抽出される。また、逆拡散部２０３ａ$_2$により信号ｋ＋１～信号２ｋからなるｋ個の信号が抽出され、同様に、逆拡散部２０３ａ$_{n-1}$により信号（ｍ－２）ｋ＋１～信号（ｍ－１）ｋからなるｋ個の信号が抽出される。

【００６０】以上の説明から明らかなように、隣接チャネル干渉波による干渉が所定のしきい値を上回るサブキャリア、および、アナログフィルタによる電力減衰や位相回転等の影響が所定のしきい値を上回るサブキャリア（すなわち、一般的に、希望信号の中心周波数から周波数軸上離れたサブキャリア）については、このサブキャリアに割り当てる信号の信号多重数を小さくする。例えば、サブキャリア１およびサブキャリアｍに割り当てる信号の信号多重数として、他のサブキャリアに割り当てる信号の信号多重数ｋに代えて、ｋ／２を用いている。

【００６１】一般に、ＯＦＤＭ－ＤＳ－ＣＤＭＡ方式においては、信号多重数を小さくすることにより、受信系における誤り率特性の劣化を抑えることができる。したがって、サブキャリア１およびサブキャリアｍにより伝送された信号に対する逆拡散処理により得られる復調信号は、誤り率特性の良好な信号となる。

【００６２】ここで、サブキャリア１およびサブキャリアｍに割り当てる信号の信号多重数を小さくしたことにより、これらのサブキャリアの伝送効率は低下するものの、総サブキャリア数が多い場合には、全体的な伝送効率の低下はわずかなものとなる。例えば、総サブキャリア数を３２とした場合、中心周波数より周波数軸上最も離れた２つのサブキャリアに割り当てる信号の信号多重数を１／２とすると、全体の伝送効率は約３％低下するのみである。

【００６３】ここまでは、隣接チャネル干渉波の中心周波数が既知である場合について説明したが、本発明は、隣接チャネル干渉波の中心周波数および信号レベルが既知でない場合や、隣接チャネル干渉波の信号レベルや位相等がフェージング等により変化する場合にも適用可能なものである。この場合には、全サブキャリアのうち、隣接チャネル干渉波の干渉等の影響が所定のしきい値を上回るサブキャリアを検出し、検出されたサブキャリアに割り当てる信号の信号多重数を小さくすればよい。

【００６４】このように、本実施の形態によれば、全サブキャリアのうち、隣接チャネル干渉波の干渉およびアナログフィルタ特性の影響を受けやすいサブキャリア（特に、希望信号の中心周波数から離れたサブキャリア）に割り当てる信号の信号多重数を、その他のサブキャリアに割り当てる信号の信号多重数より小さくすることにより、上記サブキャリアにより伝送された信号の誤り率特性の劣化を抑えることができる。換言すれば、各サブキャリアの特性、すなわち、例えば、各サブキャリアにおける隣接チャネル干渉波による影響の大きさやアナログフィルタ特性による影響の大きさに応じて、各サブキャリアに割り当てる信号の多重信号数を設定することにより、上記サブキャリアにより伝送された信号の誤り率特性の劣化を抑えることができる。

【００６５】なお、本実施の形態においては、隣接チャネル干渉波の影響およびアナログフィルタ特性の影響を受けやすいサブキャリアに割り当てる信号の信号多重数を、その他のサブキャリアに割り当てる信号の信号多重数の１／２とした場合について説明したが、本発明は、これに限定されず、隣接チャネル干渉波やアナログフィルタの影響の大きさ等に応じて上記各サブキャリア毎

に、信号多重数を設定した場合についても適用可能なものである。これにより、各サブキャリア毎に、隣接チャネル干渉波の干渉およびアナログフィルタ特性の影響が相違する場合においても、誤り率特性の劣化を抑えることができる。

【００６６】また、本実施の形態においては、中心周波数から周波数軸上離れたサブキャリアに割り当てる信号の信号多重数を小さくすることにより、さらに、以下のような効果が得られる。すなわち、ＯＦＤＭ方式、ＯＦＤＭ－ＣＤＭＡ方式およびＯＦＤＭ－ＤＳ－ＣＤＭＡ方式では、ある希望信号において、各サブキャリアのサイドローブ成分により不要周波数成分が発生する。これらの各サブキャリアによる不要周波数成分のうち、中心周波数から離れたサブキャリアのサイドローブ成分による不要周波数成分が、この希望信号による他チャネルに対する干渉成分となる。

【００６７】ここで、本実施の形態においては、信号多重数を小さくしたサブキャリアの信号レベルを小さくすることができる。すなわち、中心周波数から離れたサブキャリアの信号レベルを小さくすることができる。これにより、この希望信号が他チャネルに与える干渉をも低減させることができる。

【００６８】（実施の形態２）本実施の形態では、実施の形態１において、総サブキャリア数が少ない際に伝送効率を低下させないようにする場合について説明する。

【００６９】上述した実施の形態１においては、総サブキャリア数が多い場合には、隣接チャネル干渉波の干渉およびアナログフィルタ特性の影響を受けやすいサブキャリアに割り当てる信号の信号多重数を小さくしても、全体的な伝送効率は低下しない。ところが、総サブキャリア数が少ない場合には、上記のようなサブキャリアに割り当てる信号の信号多重数を小さくすると、全体的な伝送効率が低下する。例えば、総サブキャリア数を４とし、中心周波数から離れた２つのサブキャリアに割り当てる信号の信号多重数を、他のサブキャリアに対応する＊信号多重数の１／２とした場合には、全体的な伝送効率は１／４に低下する。

【００７０】そこで、本実施の形態においては、あるサブキャリアに割り当てる信号の信号多重数を小さくすることにより多重されなくなる信号を、ＤＣに配置したサブキャリアにより伝送する。

【００７１】以下、本実施の形態にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置について、図４および図５を参照して説明する。なお、本実施の形態における実施の形態１と相違する事項のみ説明する。図４は、ＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置におけるサブキャリアの配置の様子を示す模式図である。図５は、本発明の実施の形態２にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置におけるサブキャリアの配置の様子を示す模式図である。

【００７２】図４を参照するに、ＤＣにサブキャリアを配置した場合には、ＤＣオフセットにより誤り率特性が劣化する。さらに、総サブキャリア数は通常偶数とされるため、ＤＣにサブキャリアを配置しても、希望信号帯域は変化しない。このような理由から、ＤＣには誤り率特性の劣化を防止するため、ＤＣにはサブキャリアを配置しないことが多い。

【００７３】以下、ＤＣに配置するサブキャリアについて説明する。ＣＤＭＡ方式において、ＤＣオフセットが存在する場合を考える。逆拡散後のＤＣオフセットは、次に示す式により表現される。

【数１】

$$\sum_{n=1}^{N} \{DC \times REF(nT)/N\} \quad (n=1, 2, \cdots) \qquad -①$$

ただし、ＤＣはＤＣオフセットであり、ＲＥＦ（ｎＴ）は時刻ｎＴにおける拡散符号であり、Ｎは拡散比であり、Ｔはサンプル周期である。

【００７４】ここで、一般に、拡散符号の周期（ＮＴ）においては、ＤＣオフセットは一定であるとみなすことができるので、上式①は次式により表現される。

【数２】

$$DC \sum_{n=1}^{N} \{REF(nT)/N\} = DC\{(+1の符号数)-(-1の符号数)\}/N \qquad -②$$

【００７５】上式②において、（＋１の符号数）－（－１の符号数）＝１の場合には、ＤＣオフセットは、逆拡散により１／拡散比に減衰される。また、（＋１の符号数）と（－１の符号数）が同じである場合には、ＤＣオフセットは逆拡散により完全に除去される。以上のように、ＣＤＭＡ方式においては、ＤＣオフセットによる誤り率の劣化は低減される。

【００７６】したがって、本実施の形態にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置においては、図５に示すように、ＤＣにサブキャリア（サブキャリア＃０）を配置する。以下、ＤＣに配置したサブキャリアを「ＤＣサブキャリア（ＤＣ搬送波）」と呼ぶ。

【００７７】さらに、ＤＣサブキャリアには、あるサブ※キャリアに割り当てる信号の信号多重数を小さくすることにより多重されなくなる信号を割り当てる。すなわち、例えば、実施の形態１で説明した例では、サブキャリアｍおよびサブキャリアｍに割り当てる信号の信号多重数はｋからｋ／２とされるので、多重されなくなる信号（全ｋ個）を、ＤＣサブキャリアに割り当てる。

【００７８】このように、本実施の形態によれば、あるサブキャリアに割り当てる信号の信号多重数を小さくすることにより多重されなくなる信号を、ＤＣに配置したサブキャリアにより伝送することにより、総サブキャリア数が少ない際においても、伝送効率を低下させることなく、誤り率特性の劣化を抑えることができる。

【００７９】本発明にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ

通信装置は、ディジタル移動体通信システムにおける移動局装置や基地局装置、および、無線ＬＡＮシステムにおける通信端末装置に搭載可能なものである。

【００８０】

【発明の効果】以上説明したように、本発明によれば、搬送波（サブキャリア）の特性に応じて、各搬送波に割り当てられる信号の信号多重数を設定するようにしたので、誤り率特性の劣化を低減させるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置を提供することができる。

【図面の簡単な説明】

【図１】本発明の実施の形態１にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置の送信系の構成を示すブロック図

【図２】本発明の実施の形態１にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置の受信系の構成を示すブロック図

【図３】本発明の実施の形態１にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置における送信信号のフォーマットを示す模式図

【図４】ＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置におけるサブキャリアの配置の様子を示す模式図

【図５】本発明の実施の形態２にかかるＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置におけるサブキャリアの配置の様子を示す模式図

【図６】従来のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置における送信系の構成を示すブロック図

【図７】従来のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置における受信系の構成を示すブロック図

【図８】ＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置におけるサブキャリアの配置の様子の一例を示す模式図

【図９】従来のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置における送信信号のフォーマットを示す模式図

【図１０】従来のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置における隣接チャネル干渉波による影響の様子を示す模式図

【図１１】従来のＯＦＤＭ－ＤＳ－ＣＤＭＡ通信装置におけるアナログフィルタによる影響を示す模式図

【符号の説明】

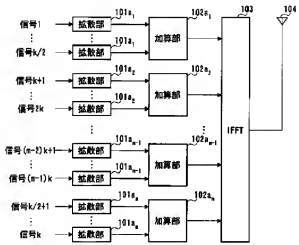
１０１a_1～１０１a_a　拡散部

１０２a_1～１０２a_a　加算部

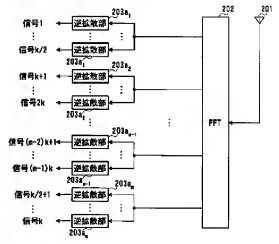
１０３　ＩＦＦＴ部

１０４　アンテナ

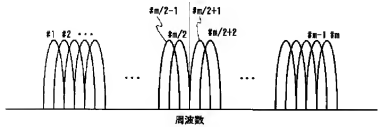
【図１】



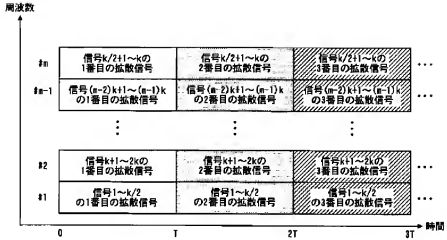
【図２】



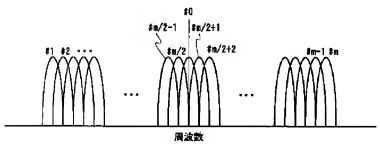
【図４】



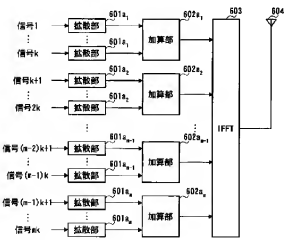
【図3】


周波数
$n
$n-1
$2
$1
信号k/2+1～kの
1番目の拡散信号
信号k/2+1～kの
2番目の拡散信号
信号k/2+1～kの
3番目の拡散信号
信号(n-2)k+1～(n-1)k
の1番目の拡散信号
信号(n-2)k+1～(n-1)k
の2番目の拡散信号
信号(n-2)k+1～(n-1)k
の3番目の拡散信号
信号k+1～2kの
1番目の拡散信号
信号k+1～2kの
2番目の拡散信号
信号k+1～2kの
3番目の拡散信号
信号1～k/2
の1番目の拡散信号
信号1～k/2
の2番目の拡散信号
信号1～k/2
の3番目の拡散信号
0
T
2T
3T
時間

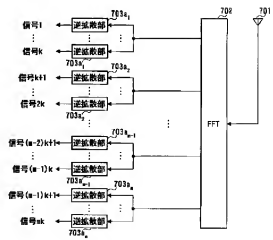
【図5】


$0
$n/2-1
$n/2+1
$n/2
$n/2+2
$1 $2
$n-1 $n
周波数

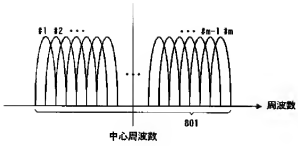
【図6】


信号1
信号k
信号k+1
信号2k
信号(n-2)k+1
信号(n-1)k
信号(n-1)k+1
信号nk
拡散部
601a1
601an
601an-1
加算部
602a1
602an-1
602an
603
IFFT
604

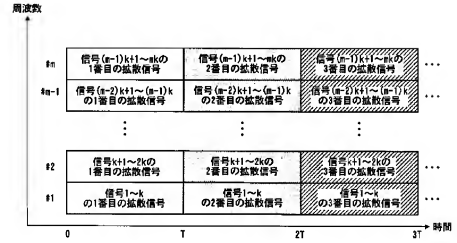
【図7】


信号1
信号k
信号k+1
信号2k
信号(n-2)k+1
信号(n-1)k
信号(n-1)k+1
信号nk
逆拡散部
703a1
703an-1
703an
708
FFT
701

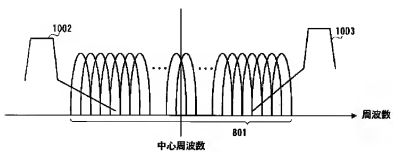
【図8】


f1 f2 ・・・
・・・ fm-1 fm
周波数
801
中心周波数

【図9】


周波数
fm
fm-1
f2
f1
信号(m-1)k+1～mkの1番目の拡散信号
信号(m-1)k+1～mkの2番目の拡散信号
信号(m-1)k+1～mkの3番目の拡散信号
信号(m-2)k+1～(m-1)kの1番目の拡散信号
信号(m-2)k+1～(m-1)kの2番目の拡散信号
信号(m-2)k+1～(m-1)kの3番目の拡散信号
信号k+1～2kの1番目の拡散信号
信号k+1～2kの2番目の拡散信号
信号k+1～2kの3番目の拡散信号
信号1～kの1番目の拡散信号
信号1～kの2番目の拡散信号
信号1～kの3番目の拡散信号
0
T
2T
3T
時間

【図10】


1002
1003
周波数
801
中心周波数

【図11】